AN OGDEN PUBLICATION DEVOTED TO GLASS TECHNOLOGY, ENGINEERING, MATERIALS AND GLASS FACTORY EQUIPMENT AND OPERATION

the glass industry

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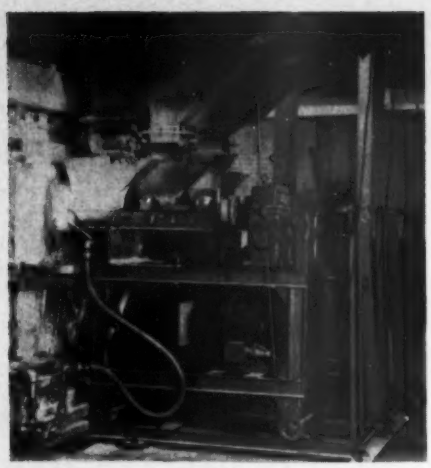

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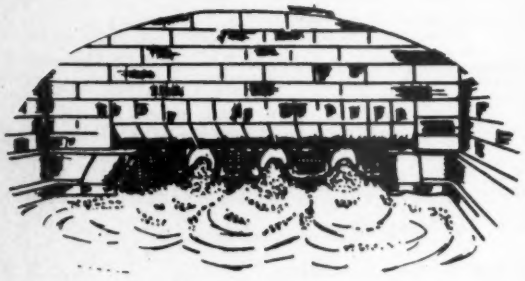

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VOLUME 36, NUMBER 4, APRIL, 1955

Thirty-Three Papers for Glass Division at Annual A.C.S. Meeting

● THE 57TH ANNUAL Meeting of the American Ceramic Society will convene in Cincinnati, Ohio, April 25 to 28. The last time the national meeting was held in this city was in 1949.

Cincinnati's hotel accommodations are such that the various Divisions of the Society must necessarily be headquartered in various hotels. The Glass Division's headquarters will be in the Sheraton-Gibson.

A total of 193 papers are programmed for presentation to all Divisions. The Glass Division has scheduled 33 and this is within one of being twice the number of papers presented to the Division in Chicago last year. It should be mentioned that the idea of restricting the number of papers in order to encourage greater discussion is still held to be highly desirable. It was felt, however, that because of the large number of papers offered for presentation, the list could not be materially curtailed without injustice to many of the authors.

Three major symposia will be featured in the technical sessions, with several Divisions participating in each. The three symposia are "Sealing Ceramic-to-Metal Seals," "Fundamentals of Color and Color Measurements" and "Color Control in Ceramics." Symposia papers of specific interest to glass members to be presented in joint sessions of the Glass Division with others are as follows:

Symposium: Fundamentals of Color and Color Measurement: (Joint session with Design, Glass, Materials & Equipment and Whitewares Divisions)

5. Introduction to Color. By I. A. Balinkin, University of Cincinnati, Cincinnati, Ohio.
6. Instrumental Methods of Color and Color Difference Measurements. By R. S. Hunter, Hunter Associates Laboratory, Falls Church, Va.
7. The Evaluation of Small Color Differences: Part I, Visual Observation. By J. C. Richmond and W. N. Harrison, National Bureau of Standards, Washington, D. C.
8. The Evaluation of Small Color Differences: Part II, Spectrophotometric Determinations. By H. J. Keegan, National Bureau of Standards, Washington, D. C.
9. The Evaluation of Small Color Differences: Part III, Colorimetry. By H. K. Hammond, III, National Bureau of Standards, Washington, D. C., and R. S. Hunter, Hunter Associates Laboratory, Falls Church, Va.

Symposium: Color Control in the Ceramic Industry: (Joint session with Design, Glass, Materials & Equipment and Whitewares Divisions)

13. Color Control in the Glass Industry. By A. J. Werner, Corning Glass Works, Corning, New York.
14. Color Control in the Dinnerware Industry. By R. L. Gibson, Shenango China, Inc., New Castle, Pa.
15. Color Control in the Sanitaryware Industry. By W. H. Merry, Richmond Radiator Company, Monaca, Pa.
16. Color Control in the Tile Industry. By H. R. Goodrich, Gladding, McBean & Company, Los Angeles, California.
17. Hydrogen Behavior in Glass Coating of Steels and Alloys. By G. P. K. Chu and E. A. Sanford, The Pfaudler Company, Rochester, New York.

The Symposium on Sealing, to be held under the auspices of the Glass Division in joint session with the Whitewares Division, Papers 13 to 19, are included in the following list of Glass Division papers.

1. Some Physical Factors Affecting the Internal Damping of Glass. By S. L. Blum, Raytheon Manufacturing Company, Waltham, Mass.
2. Infrared Spectra and Atomic Arrangement in Fused Boron Oxide and Soda Borate Glasses. By Scott Anderson, R. L. Bohn and D. D. Kimpton, The Anderson Physical Laboratory, Champaign, Ill.
3. A Basic Study of the Structure of Hyper-Eutectic Glasses and Their Characteristics: Structure. By R. L. Hess and R. K. Gupta, University of Michigan, Ann Arbor, Mich.
4. The Study of Glass by Nuclear Magnetic Resonance. By G. R. Holzman, Mellon Institute of Industrial Research, Pittsburgh, Pa.
5. Hydrogen Treatment of Lead Glass for High-

Voltage Electron Tubes. By John Gallup and Leona Mogey, Radio Corporation of America, Harrison, N. J.

6. Expansion, Setting Point and Stress Relations in Glass. By F. W. Martin, Corning Glass Works, Corning, N. Y.
7. Fundamental Thermal Stress Analysis of Enamel-Metal Systems. By J. H. Lauchner, R. L. Cook and A. I. Andrews, University of Illinois, Urbana, Ill.
8. Why Thermodynamics Does Not Give the Correct Answers to Many Sealing Problems. By Leo Brewer, University of California, Berkeley, Calif.
9. The Role of Surface Tension and Wetting in Metal-Ceramic Sealing. By W. D. Kingery, Massachusetts Institute of Technology, Cambridge, Mass.
10. Effect of Temperature and Oxide Additions on the Wettability of Metals by Glass. By R. M. Fulrath, S. P. Mitoff and J. A. Pask, University of California, Berkeley, Calif.
11. Nature of Adhesion. By F. W. Reinhart, National Bureau of Standards, Washington, D. C.
12. Theories for the Adherence of Vitreous Enamels to Metals. By Dwight G. Moore, National Bureau of Standards, Washington, D. C.
13. Structural Aspects of the Metal-Glass Colored TV Bulb. By A. S. Rose, I-T-E Circuit Breaker Company, Philadelphia, Pa.
14. Solder Glass Sealing. By R. H. Dalton, Corning Glass Works, Corning, N. Y.
15. Properties of Some Low Temperature Solder Glasses. By John Gallup and A. G. Dingwall, Radio Corporation of America, Harrison, N. J.
16. Trends in Design of Ceramic-to-Metal Seals for Magnetrons. By Leo J. Cronin, Raytheon Manufacturing Company, Waltham, Mass.
17. Applications of Ceramics to Vacuum Tubes. By R. E. Manfredi and H. J. Nolte, General Electric Company, Schenectady, N. Y.
18. Active Metal Sealing in Metal-Ceramic Hermetic Terminal Applications. By Hayne Palmour III, American Lava Corporation, Chattanooga, Tenn.
19. The Application of Ceramic Sections in High Power Pulsed Klystrons. By Louis H. LaForge, Jr., Stanford University, Stanford, Calif.
20. Strength of Glass Rods. By R. M. Witucki and Thomas Whalen, Pennsylvania State University, State College, Pa.
21. A Basic Study of the Structure of Hyper-Eutectic Glasses and their Characteristics: Strength. By R. L. Hess and R. K. Gupta, University of Michigan, Ann Arbor, Mich.
22. Flaw Distributions and the Variation of Glass Strength With Dimensions of the Sample. By C. H. Greene, New York State College of Ceramics, Alfred, New York.
23. Modifications of Twyman's Equation and their Significance. By A. Q. Tool, Takoma Park, Md.
24. A Basic Study of the Structure of Hyper-Eutectic Glasses and their Characteristics: Chemical Durability. By R. L. Hess and R. K. Gupta, University of Michigan, Ann Arbor, Mich.
25. Dielectric Losses in Glasses. By H. T. Smyth, Rutgers University, New Brunswick, N. J.
26. Oxide Glasses, With or Without Silica, for Infrared Applications. By J. M. Florence, F. W. Glaze and M. H. Black, National Bureau of Standards, Washington, D. C.
27. Surface Tension, Density, Viscosity and Electrical Resistivity of Binary Alkaline-Earth Borates Containing Three Mole Per Cent of Potassium Oxide. By Leo Shartsis, L. W. Coughanour and H. F. Shermer, National Bureau of Standards, Washington, D. C.
28. Far Ultraviolet Spectra of Various Minerals and Glasses. By K. B. Klevens, Mellon Institute of Industrial Research, Pittsburgh, Pa.
29. Luminous Flux Transfer in Glass by a Network Method. By P. F. O'Brien, University of California, Berkeley, Calif.
30. The Colors of Platinum, Palladium and Rhodium in Simple Glasses. By G. E. Rindone and J. E. Rhoads, Pennsylvania State University, State College, Pa.
31. The Production of Color Centers by X-Rays in Rather Pure Fused Silica. Part II. By A. J. Cohen, Mellon Institute of Industrial Research, Pittsburgh, Pa.
32. Barium Titanium Silicate Glasses. By E. H. Hamilton and G. W. Cleek, National Bureau of Standards, Washington, D. C.
33. Antimony Oxide Glasses. By W. A. Hedden and B. W. King, Battelle Memorial Institute, Columbus, Ohio.

The Basic Science Division, which also offers a total of 33 papers, will as usual have papers of interest to many glass scientists attending the meeting. In the Design Division, John B. Ward, Director of Design, Corning Glass Works, will present a paper, "What Industry Expects of the Designer." Charles N. Carlson, President of United States Glass Company, and Ernest Lilga, General Manager of Inland Glass Company, will participate in a Panel Discussion, "Management Discusses Design." Another Panel Discussion, "Design from the Production and Sales Viewpoints," will include representatives from Corning Glass Works and Fostoria Glass Company.

The Refractories Division, with 28 papers scheduled, will also offer glassmen discussions of specific interest.

Dr. Alexander Silverman will deliver the Edward Orton, Jr. Fellow Lecture. His subject—"Glass Through the Ages." On the same program will be E. S. Bettis, principal development engineer for Oak Ridge National Laboratory. The title of his address is "Technical Personnel for Research Today."

There will be the usual general meetings, and evening floor show and dancing. Tours of plants in the Cincinnati area are planned and, of course, the Annual Banquet. Speaker for the banquet will be James "Scotty" Robertson of the Globe Office Equipment Company.

Engineering students from a dozen ceramic schools will compete in the annual student speaking contest. Others will serve as pages. A student employment service will bring together seniors and prospective employers.

Presiding over this 57th Annual Meeting will be Ray W. Pafford, President of the American Ceramic Society. At the annual banquet he will install his successor, Robert Twells of Fostoria, Ohio. W. E. Dougherty of Pittsburgh

(*Continued on page* 234)

Thermal Emissivity of Refractories and Its Importance for Glass Furnace Operation

INFORMATION CIRCULARS OF THE INSTITUTE OF SILICATE RESEARCH

● THE ACCURATE measurement of the temperatures of heat-radiating surfaces of refractories is of fundamental importance in the study of glass melting and fining processes in modern tank furnaces. Obviously, thermoelectric pyrometers cannot be applied to every point in the structure, which would perhaps best correspond to ideal requirements of temperature control. In many parts of the hot furnace, the engineer still depends on rough estimates of the heat transfer from the flame gases to the surface of the refractory walls, and to the glass surface. Therefore, the laws of heat radiation must be familiar to the engineer to such a degree that he knows how to use the indications of optical (radiation) pyrometers with all the critical conditions governing the ratio of indicated and true temperatures, and their distribution over radiating surfaces.

In the olden days of pot glass melting, the control could only be done by estimation from the *color* of the radiating surfaces. "Red," "yellow" and "white" heat could prove sufficient to a certain degree when handicraftsmen worked exclusively on the basis of empirical tradition. But in the progressive development of modern physics, the laws of spectral dispersion of radiated light as a function of temperatures have given new and reliable basis for the accurate measurement of the latter. The first fundamental radiation law is that of Stefan (1879) and Boltzmann (1884), expressed in the formula for the thermal radiancy, R_{bl}, of a "blackbody": $R_{bl} = \sigma T^4$, with the constant $\sigma = 5.672 \times 10^{-5}$ erg/cm²/°K⁴. An ideal "blackbody" is a material which emits the maximum total radiation energy at a given temperature. The properties ascribed to the "blackbody" are expressed through the fact that the unit emissivity, $\varepsilon_t = 1$, is characteristic for it. It is immediately evident that other heat radiating materials which are not able to send out, at the same temperature, the maximum energy of radiation must have lower emissivities than the unit for the blackbody: ε_t for them is less than unity. The problem is how to determine the important numerical value of this property for practical purposes. If the emissivity of a heat-radiating part of a furnace system is known, we are able to correct every measurement of apparent (indicated) radiation temperatures, T_a, by introducing the emissivity of the heat-radiating part, and to derive the true (blackbody) temperature, T_{bl}, by the equation $T_{bl} = T_a/\sqrt[4]{\varepsilon_t}$.

A second fundamental law of radiation—thermal and optical radiation are in this respect entirely equivalent—concerns the interrelation of the radiancy for given wavelengths of the radiated energy, R_λ. This is expressed in the equation of Wien (1893): $R_\lambda = c_1\lambda^{-5}e^{-c_2}/\lambda T$, and has been theoretically confirmed by Planck's quantum theory, introducing the universal constant $h = 6.824 \times 10^{-27}$erg sec, and the speed of electromagnetic waves (light), $c = h\nu = 2.99776 \times 10^{10}$ cm/sec. In this formulation, the spectral emission of energy is

$$R_\lambda = 2\pi hc^2 \frac{\lambda^{-5}}{e^{hc/\lambda kT} - 1}$$

(k is Boltzmann's constant, $= 1.3805 \times 10^{-16}$erg/°K/particle). For our practical use it is sufficient to calculate from Wien's law the wavelength, λ_{max}, for the radiation of maximum intensity from a blackbody radiator, which has the absolute temperature T_{max}: $\lambda_{max} \times T_{max} =$ constant $= 0.28972$ cm °k. A graph based on this equation (in double-logarithmic projection) is given in Fig. 1.

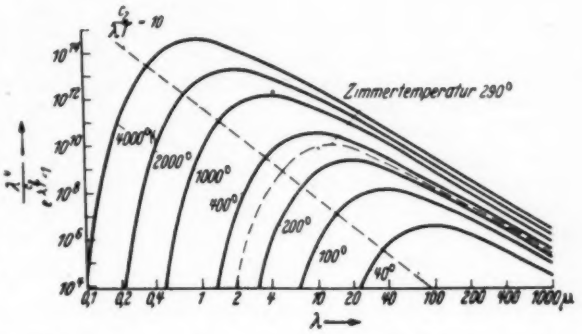


Fig. 1. Isotherms of the Planck Radiation Law, in double-logarithmic projection. (M. Czerny and H. Roeder, 1938).

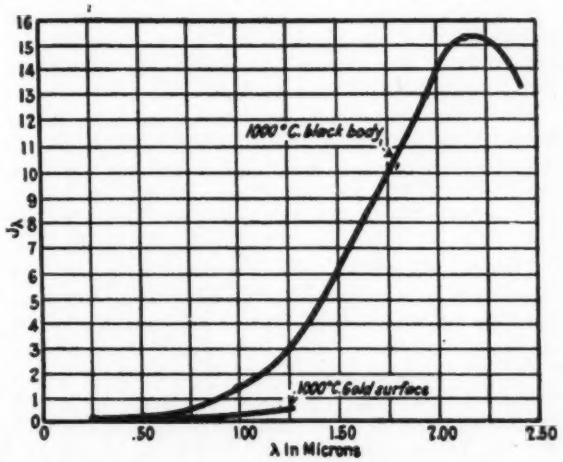


Fig. 2. Blackbody radiation isotherm for 1000°C., and emission of the surface of gold at the same temperature in the short-wave infrared.

Paper read in the Fall Meeting of the Ohio Section, American Physical Society, on Oct. 9, 1954 in University Hall, University of Toledo. Based upon the latest data in the publication of Dr. M. Michaud, Silicates Industriels, Vol. 19, 1954, No. 6/7, pp. 243-250.

It is not adequate for the technician to determine temperatures of radiating surfaces by measuring the wavelengths of highest radiation intensity; however, it is much more convenient to start from a constant wavelength given by an approximately monochromatic filter glass, and to measure the intensity of the transmitted energy. This principle, applied to an ideal blackbody radiator, gives also a sufficient accuracy for monochromatic conditions in determining the characteristic ("true") temperature under ideal conditions of blackbody radiation if corresponding instrumental arrangements are made (see below). If blackbody conditions cannot be verified, then only a "brightness temperature," S_λ, is determined from the given radiator. The spectral monochromatic "brightness," B_λ, is defined by an equation derived from Wien's law, for a temperature T, in its relation to a conventional calibration brightness, B_o, at the calibration temperature, T_o, namely by $\ln (B_\lambda/B_o) = -c_2/\lambda . (1/T_o - 1/T)$. The brightness temperature, S_λ, and the true temperature, T_{bl}, is given by the relation $1/T_{bl} = 1/S_\lambda + 1/c_2 . \ln e_\lambda$ (with $c_2 = hc/k = 1.4385$ cm°K), as a function of the spectral emissivity, e_λ. With this somewhat inconvenient formula, the indicated brightness temperature, S_λ of a monochromatic radiation energy measurement is to be corrected to find the true temperature.

Apparent radiation temperatures are determined by two different groups of instruments: either total radiation pyrometers which, for the measurement, use a given function of the impinging energy in toto,—or spectral pyrometers which, for the same purpose, use only that fraction which is transmitted by a filter for one or the other defined wavelength of the impinging radiation. For the temperature correction we need, for the first class, the "total emissivity," ε_t, and for the second class, the "monochromatic" emissivity, ε_λ. In addition, it is important to remember from Kirchhoff's law that emissivity is equivalent to "absorptivity," either total or monochromatic, α_t and α_λ, respectively, for any material. There are, in wide limits, variations of the emissivity with temperature and wavelengths which are of high importance for the metallurgist and the glassmaker. Metals with their very smooth surface in the liquid form or in high-polished state, have low emissivities (Fig. 2); refractory oxides, silicates, etc., medium emissivities; while graphite, silicon carbide, etc., have higher emissivities, which are distinct functions of temperature and also particularly of the smoothness of their surfaces. The rougher the surface, the higher the emissivity, which is an empirical rule.[1]

This latter effect which, for many refractories in industrial high-temperature furnaces, is even of higher importance than the specific effects of variable chemical composition, is best understood by a short excursion on the verification of blackbodies, which we better characterize as "cavity radiators." It is not essential that we find for its verification a material with $\alpha_t = 1$ and $\varepsilon_t = 1$ (which does not strictly exist), but to find an arrangement in which an often repeated inner diffuse reflection of temperature-emitted radiation is possible. O. Lummer and E. Pringsheim[2] used an electrically heated tube in which such an inner repeated reflection took place which passed through a system of diaphragms and a narrow exit hole (Fig. 3). The energy leaving this hole in the axial direc-

Fig. 3. Blackbody of Lummer and Kurlbaum (1903). (Gehlhoff, 1926).

tion is taken as the basis for the calculation of the true temperature in the system. Another practical version of this principle is that of a spherical cavity in which the often repeated reflection occurs before the radiant energy can leave the cavity through the narrow hole. In principle it is irrelevant of which material the heated body is constructed. Every material will do, and it is only appropriate to make the calibrations with metal oxides of high emissivity ε_t covering the inside of the cavity, e.g. with nickel or cobalt oxide which are "very black" (ε_t about 0.95).

Similar less regularly shaped cavity radiators may be assumed on rough surfaces of refractory material, even of low emissivity in the smooth state, if the principle of repeated inner reflections is maintained. Such a surface is shown in Fig. 4 in which wedge-shaped or rounded cavities really "capture" the radiation from an arbitrary point of the inner surface to reflect it from wall to wall before it can "escape" as a beam with the radiant energy characteristic for the "black" radiation. The rougher the surface, the higher must be the emissivity of the given refractory material. This is the reason for the important conclusion that it is meaningless to speak of "heat emissivities" as "constants" of a given material, e.g. as a distinct refractory oxide, or silicate, or any other wall material of furnaces. Without a definition of the "granular composition" (granulometry) of the material, even technological tables for "emissivity constants" are useless for the practitioner. His ignorance or neglect of this fact often enough would bring about tremendous errors in the calculation of true temperatures from the usually determined apparent temperatures, indicated by optical or radiation pyrometers. For the metallurgist these conditions have long been familiar enough because, e.g., polished copper has the value ε_t in the order of magnitude of 10^{-2}; for molten copper ε_t is 0.13 to 0.16, and for the metal plate heated in open air at about 600°C. it is 0.57. Of course, this latter anomaly is explained by the thin oxide layer formed on the metal, but also for rolled plates, rubbed with emery. ε_t is, e.g., 0.20. The roughened surface, therefore, shows a much increased emissivity. If the oxide formed on the metal is "white," not as strongly colored as copper or nickel oxide, the emissivity is nevertheless much higher than that of polished metal. The gray, slightly oxidized sheet iron shows, e.g., an ε_t of 0.276, while polished zinc has $\varepsilon_t = 0.05$, and iron about the same.

From the scientific viewpoint, the problem of accurate determinations of emissivities is not an easy task, and much of the tabulated data cannot be used without considerable criticism. Therefore, it is fortunate that M. Michaud* has recently published a series of really modern measurements of well defined refractory materials. We use his results and methods for an illustration of what is essential for the knowledge of the glass furnace engineer. Particularly important will be, in this connection, the discussion of the effects of variable granulometry and the comparison between total and monochromatic emissivities as functions of temperature.

Cylindrical samples (Fig. 5) from the given refractories (cut with a diamond saw from commercial brick)

*Silicates Industriels *19*. 1954 (6/7) 243-250; "Facteurs d'émission d'oxydes métalliques et réfractaires à haute température." 1954; this monograph is available at "Francosteel Inc.," 41 E. 42nd St., New York 17, New York.

were prepared of 20mm diameter and 50mm length. On both ends cylindrical cavities were drilled, one of them for fixing a silica glass rod as axial support of the cylinder for rotation, the other to form the radiation cavity of approximately blackbody properties for the determination of the true temperature. The cavity was 20mm deep and had a hole with a diameter of 4mm onto which the optical axis of a visual pyrometer of the disappearing filament type (Holborn and Kurlbaum, Ribaud) was directed. This pyrometer could be rotated from the position I to another position II in an angle of 90° around an axis exactly perpendicular to the axis of the cylindrical sample. In position II, the optical axis of the pyrometer was directed on a small surface of the sample in the same plane with the bottom of the cylindrical cavity. The measured temperature in position II is a monochromatic brightness temperature, as defined above. The temperature of radiance which corresponds to the total emissivity of the material in question was measured by a total radiation, lensless pyrometer, with a thermopile as the sensitive receiver of the impinging radiation energy.

The sample was heated by a coal gas, oxygen burner, the longitudinal opening of which was oriented parallel to the axis of the cylindrical sample.[3] During the measurements, the sample was continuously rotated around its axis in the flame with a controlled speed.* At the same time, the burner was moved back and forth along the longitudinal opening. The non-luminous flame of the gas burner did not affect the monochromatic emissivity determinations, but the total radiation is somewhat influenced by the proper specific emission of the flame gases in the intense infrared emission wavelengths of H_2O ($\lambda = 2.75\mu$) and CO_2 ($\lambda = 4.25\mu$) (Fig. 6). No correction, however, was applied to the measurements because of the inconsiderable thickness of the flame layer surrounding the sample.

Using the equation given above, from the true temperature measured directly by the monochromatic optical pyrometer (and corrected for the calculated deviations of the geometrical shape of the cavity from the ideal 100 per cent blackbody radiator),** the known brightness temperature and radiance gave the results for ε_λ and ε_t. The most representative results are tabulated in Table I, in which only the monochromatic ε_λ data for red ($\lambda = .655\mu$) are given.† For the special alumina refractories given in Table II also the granulometric compositions are given in sieve fractions of the ingredients. The chemical compositions are given in Table III. In addition some measurements were made for a direct determination of the "rugosity" of the materials with the Schmaltz light-section method†† and the Nicolau pneumatic porosity tester.‡

TABLE I
Monochromatic Emissivities (for λ=0.655μ), and Total Emissivities of Refractories at Variable Temperatures

Temperature	1000°	1100°	1200°	1300°	1400°	1500°	1600°
Monochromatic emissivities:							
R.A. 98	0.57	0.51	0.45	0.44	0.42	0.40	0.40
R.A. 360	0.39	0.33	0.29	0.275	0.27	0.26	0.25
R.A. 84	0.157	0.157	0.157	0.157	0.157	0.157	0.157
1194 S	0.25	0.275	0.285	0.295	0.30	0.31	0.315
F	0.15	0.15	0.15	0.15	0.15	0.15	0.15
A1 90	(0.40)	0.46	0.52	0.58	0.63	(0.66)	
A,D,E	0.50	0.50	0.50	0.50	0.50	0.50	
E_t	0.18	0.18	0.18	0.18	0.18	0.18	
No. 40-685	0.50	0.50	0.55	0.60	0.62	0.65	
D No. 2	0.50	0.48	0.45	0.43	0.415	0.40	
D No. 3	0.50	0.50	0.50	0.50	0.50	0.50	
D No. 4, 5	0.71	0.71	0.71	0.71	0.71	0.71	
Sèvres	(0.66)	0.66	0.66	0.66	0.66	(0.66)	
F à C No. 38-755	0.88	0.84	0.79	0.76	0.755	0.75	
No. 39-723	0.75	0.73	0.72	0.70	0.69	0.68	
Carborundum	0.88	0.88	0.88	0.88	0.88	0.88	
Semi-Carborundum	0.88	0.84	0.80	0.76	0.755		
ThO_2				0.40			
Total Emissivities:							
R.A. 98	0.50	0.48	0.46	0.43	0.41	0.40	0.39
R.A. 360	0.39	0.36	0.34	0.32	0.30	0.285	0.275
R.A. 84	0.325	0.30	0.275	0.26	0.245	0.23	0.22
1194 S	0.39	0.35	0.33	0.30	0.29	0.28	0.27
F	0.30	0.28	0.25	0.23	0.20	0.19	0.18
A1 90	(0.53)	0.53	0.53	0.53	0.53	0.53	0.53
A,D,E	0.62	0.58	0.535	0.51	0.49	0.46	
E_t	0.42	0.42	0.41	0.35	0.34	0.33	
No. 40-685	0.62	0.60	0.58	0.57	0.55	(0.53)	
D No. 2	0.61	0.55	0.508	0.465	0.435	0.407	
D No. 3	0.61	0.55	0.52	0.475	0.468	0.45	
D No. 4, 5	0.73	0.70	0.68	0.653	0.62	0.62	
No. 39-723	0.80	0.77	0.75	0.73	0.705	0.69	
Carborundum	0.92	0.91	0.90	0.89	0.88	0.87	
Semi-Carborundum	0.86	0.83	0.79	0.755	0.74		
Graphite	0.91	0.91	0.91				

*These experimental conditions, which concern the rotation direction and the correct spot on which the optical axis of the pyrometer must be directed, is extensively discussd in Michaud's monograph, pages 15ff., the effects of the flame gases on pp. 38-43.

**The extensive discussion of these important corrections must be studied in Michaud's monograph, pp. 19-33.

†The monograph of Michaud gives additional data of ε_λ for λ=.525μ.

††G. Schmaltz, "Technische Oberflaechenkunde," Berlin 1936, J. Springer Verlag; Naturwiss. 25. 1937. 508-512.

‡Nicolau, Mécanique, March 1937, Jan. 1938; Génie Civil, Febr. 1939; Journées internationales de Chromométrie et Métrologie, Paris, 1937.

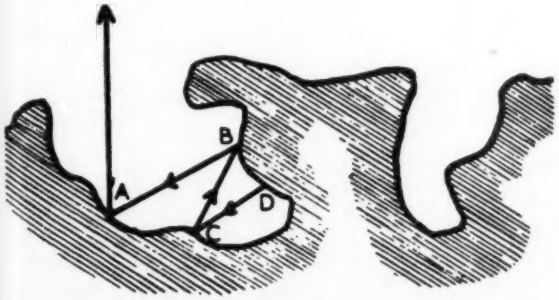


Fig. 4. Principle of energy emission from a rough surface, approximating the conditions of black radiation. (Kirchhoff; Bosworth. 1952).

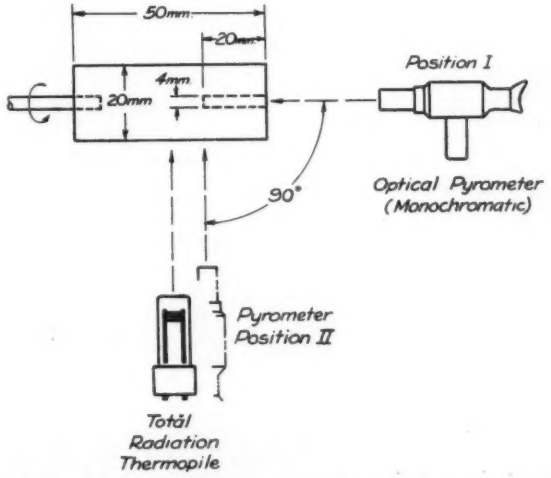


Fig. 5. Principle of the measurement of true temperatures, brightness temperatures and radiation temperatures on a refractory sample. (Michaud, 1954).

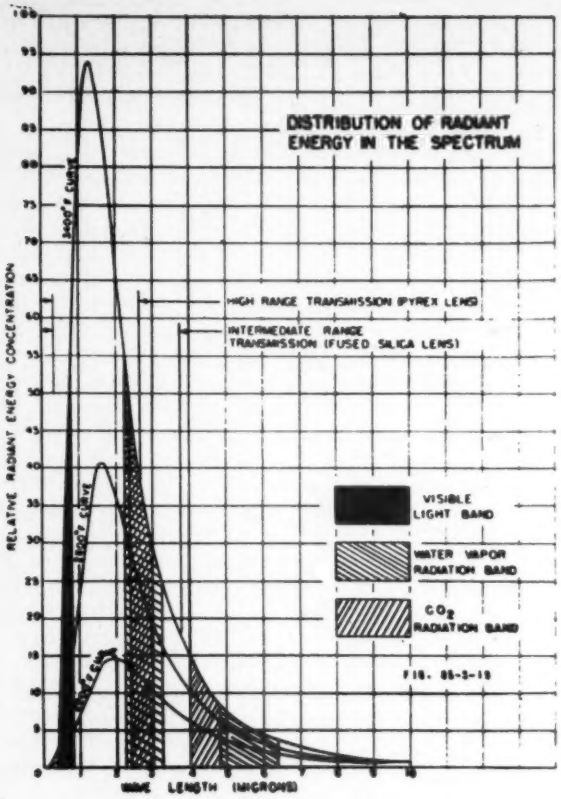

DISTRIBUTION OF RADIANT ENERGY IN THE SPECTRUM
RELATIVE RADIANT ENERGY CONCENTRATION
HIGH RANGE TRANSMISSION (PYREX LENS)
INTERMEDIATE RANGE TRANSMISSION (FUSED SILICA LENS)
VISIBLE LIGHT BAND
WATER VAPOR RADIATION BAND
CO_2 RADIATION BAND
FIG. 85-3-13
WAVE LENGTH (MICRONS)

Fig. 6. Distribution of radiant energy in the visible and infrared spectrum, with the emission bands of water and carbon dioxide. (J. P. Vollrath, 1945).

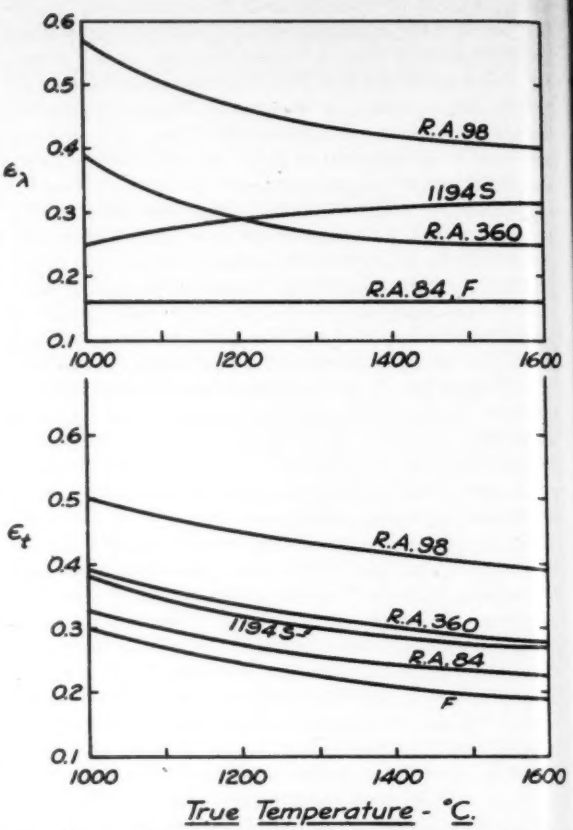


Fig. 7. Temperature functions of the emission from alumina refractories. (Michaud, 1954).

The maximum (H_r) and average (h_r) depths of the cavities are given in Table III.

Nearly pure alumina and silica bodies do not appear to be much different, in general, concerning their monochromatic emissivities, but there is a very distinct effect of the granulometric conditions. The emissivities are also functions of the wavelengths, and of the temperature as seen in Figs. 7, 8, 9. The accuracy of the data of the total emissivity are in general better than those of the monochromatic data because the errors of the measurement for the monochromatic brightness temperatures are ± 10° at 1000°C., ± 20° at 1500°C., but for the total radiation temperatures ± 5° in the temperature range from 600° to 900°, and ± 10° between 900° and 1300°C. The true temperature is accurate to ± 3° at 1000°, to ± 5° at 1500°C. The yellowish or red-brown color of fireclay refractories did not affect too much the radiation emissivity data; also the effects of oxidizing or reducing flame conditions evidently have not been appreciable in the given limits of error. They may be neglected for all the "white" refractories. However, if an alumina rod was impregnated with iron chloride and fired, the deep-brown colored surface showed a distinctly higher emissivity than the original white material had shown. This fact is in

TABLE II

Granulometric Composition of Refractories used for the Determination of Thermal Emissivities

Sieve Numbers	90	120	150	180	240	320	500	Finest (clay)	Porosity Vol. %	H_r	h_r
R.A. 98	10	10	25	40				15	48	96μ	49μ
R.A. 360					42.5	42.5		15	41	38″	18″
R.A. 84							85	15	37	10″	5.4″
Grain Sizes (μ)	200	150	120	90	61	40	≤ 12				
1194 S		50					40		37.9		
F							100				
A } Grain	0.6mm										
D } Size	0.3mm										
E }	0.07-0.08mm										
D No. 2, 3, 4, 5	0.1mm										
Al 90									16		
No. 38-755									28		

agreement with the classical experiments of Rubens[4] who studied the radiation of an Auer von Welsbach mantle which has a very low emissivity in the infrared but glows with a high emissivity in this region if impregnated with iron oxide. The indicated (apparent) radiation temperature is then tremendously reduced, and the mantle glows in a deep-red color.

Some of the particular effects worth remarking are the following: The monochromatic emissivity of siliceous fireclay material is about the same as that of aluminous fireclay refractories, but the total emissivity is higher for SiO_2 than for alumina. With increasing temperature, the monochromatic emissivity is rather constant, or even slightly decreasing, while the total emissivity is much more decreased. The brightness and radiation temperatures are approximately linear functions of the true temperatures for both kinds of refractories; the absolute numerical data are lower for the monochromatic emissivity than for the total emissivity. These differences, however, decrease with increasing temperature. They are chiefly determined by the granulometry: the finer grained and less colored refractories show higher differences between total and monochromatic emissivity.

The excellent publication of M. Michaud is of highly practical value for many important questions, not only from the viewpoint of temperature corrections for pyrometers, but also in the investigation of heat transfer in the glass or related metallurgical furnace. The most important general statements of Michaud submit the conclusion that it would be highly erroneous to assume that the interior of an industrial furnace would radiate as a blackbody. From industrial and semi-industrial experiments is further concluded that certain empirical ε_λ for $\lambda = .655\mu$ and ε_t can be used for coarse-granular fireclay and for silica brick roofs to correct the readings of optical pyrometers. The steady development of basic refractories for walls and roofs of open hearth furnaces in the steel industry awoke much interest on the emission from the surface of forsterite and magnesite brick, which have not yet been considered in Michaud's experiments.* It is to be expected that these types of refractories have high emissivities because of their deep brownish color and relatively high iron oxide contents. The conditions of emission from the roof or the walls of silica, and from magnesite brick, in this case, would be much different. Michaud discussed also the important deviations of emission conditions of half-transmittent (translucent) or even transparent (diathermanous) radiators from those of a perfectly opaque radiating body. An extreme problem in this connection is the radiation of glass melts which is connected with the char-

(*Continued on page* 228)

*See the interesting results of the experiments of G. Naeser and W. Pepperhoff, Stahl u. Eisen *69*. 1949. 325-328.

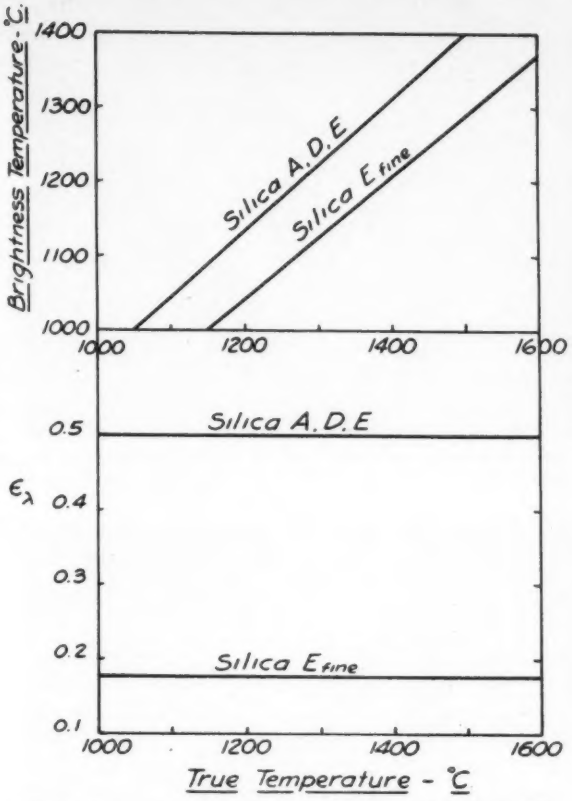
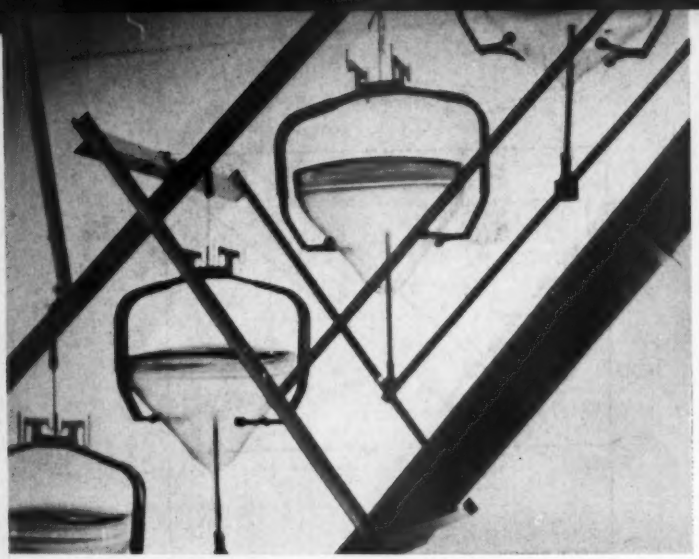


Fig. 8. Temperature functions of the emission from silica refractories of different granulometric composition. Brightness temperatures. (Michaud, 1954).

TABLE III

Chemical Composition and Densities of the Refractories

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Alkalies	Ign. Loss	Color	apparent Density	true Density
R.A. 98	8.63	89.74	0.64	0.24					white		
R.A. 360	12.00	85.38	0.95	0.35					white		
R.A. 84	18.90	78.45	1.10	0.36	0.56	0.14	0.74	0.12	white		
maxim. errors ±	0.20	0.30	0.05	0.05	0.05	0.02	0.20	0.02			
1194 S	2.7	96.7							white	2.37	3.82
F		99.5							white		
Al 90		90							rose	2.9	
No. 40-685	94.9	2	1		2				white	1.79	2.33
D No. 2	16.3	79.9	0.42	.09	.06		1.15		yellowish		
D No. 3	38	58	0.4	1					yellowish		
D No. 4	59.5	26.3	1.7	1.45	0.8	0.15	1.0		brown		
D No. 5	50	36	1.65		0.6				brown		
Sèvres	61.2	37.8	1.7		0.85	0.15			reddish-brown		
No. 38-755	74.5	22.3	2.3						reddish-yellow	1.86	2.58
No. 39-723	60.9	35.4	2.9						reddish-yellow		

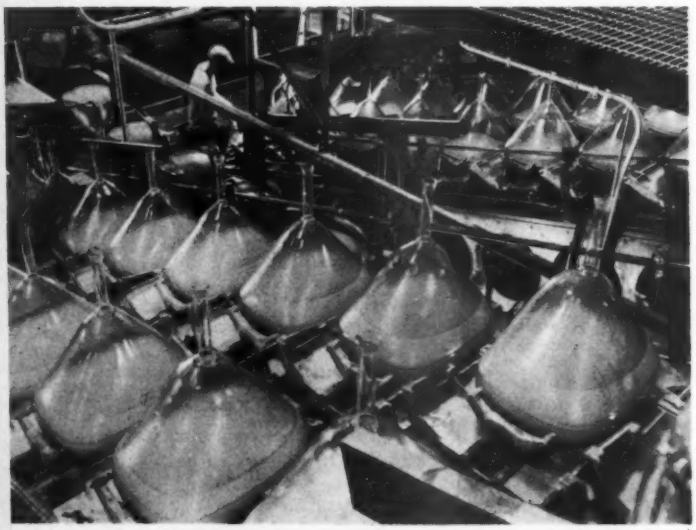


Bulbs enroute to a drying manifold where jets will blow hot, dehumidified air into the rubber tubes here shown in the necks of the bulbs.

Bulbs are examined first in lamplight for visual inspection of glass and screen, then under "black light" which animates the phosphor and shows whether it is evenly distributed.

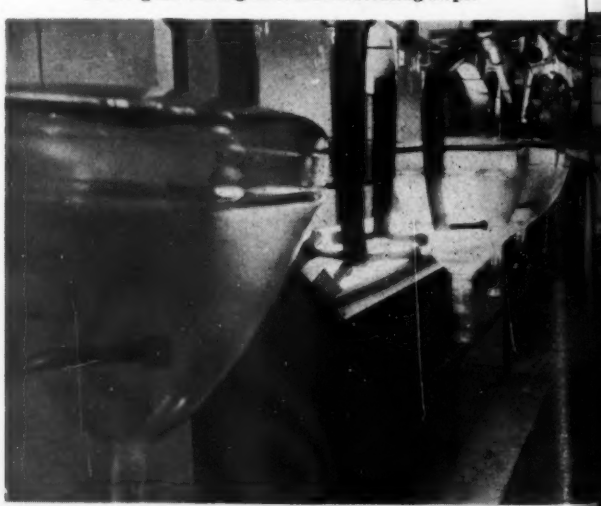
Automatic Machines an Production Lev

● AUTOMATIC MACHINES, a far-flung conveyor system and approximately one thousand employees working three shifts six days a week make the new CBS-Hytron plant at Kalamazoo, Michigan, one of the world's largest producers of black-and-white television picture tubes. On Kilgore Road at the city's southeastern edge, the 250,000 square-foot factory utilizes equipment for the most part engineered and built at CBS-Hytron plants in Danvers and Newburyport, Mass. From its production lines go



In the "settling" process shown, phosphor particles slowly descend through their liquid cushion to form a screen on the inside of the face-plate where the television picture will eventually appear. The phosphor suspension enters the bulbs through tubes at upper left.

Below left:
The bulbs decant their liquid cushion after the settling process.
Below:
Bulbs begin the washing operation. The faces are coated in order to reveal subsequent splashes of "kasil," or phosphor suspension, which, if undetected, would bake as permanent flaws in the glass during later manufacturing steps.



Inside blackening. Here an operator holds an applicator of carbon paint inside the whirling bulb, and spreads a black band which will nullify electrons "bouncing" from the screen while the tube is in use.

The impulses which animate the screen must be focused by an electronic "lens." Here an operator welds the connector for a focus electrode in an electrostatic "gun."

anpower Attain High t CBS-Hytron

By J. STANLEY BROTHERS

picture tubes to most of the nation's leading TV set manufacturers.

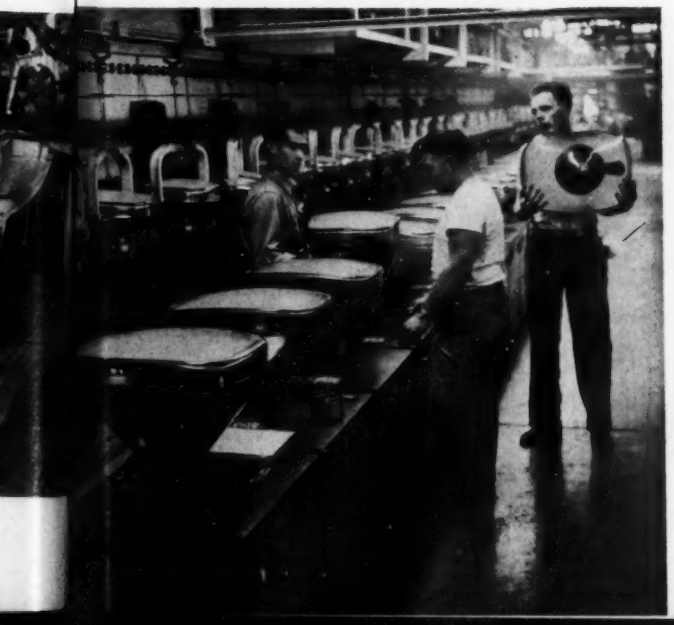
Kalamazoo's accessibility to Midwest markets and transportation facilities played a part in CBS-Hytron's choice of that city as a site for expansion; so did its proximity to sources of glass "envelopes," or raw bulbs—the Corning Glass Works at nearby Albion, Michigan, and the Kimble Division of Owens-Illinois at Columbus, Ohio.

The envelopes reach Kalamazoo for processing with their glass component parts sealed together—neck, funnel and the face-plate which will ultimately be the picture panel—and with an anode "button" fused into the bulb's side to provide one of the voltage contacts. Already inspected and checked for mechanical, thermal and optical characteristics by the glassmaker, the bulbs receive further critical examination upon arrival at CBS-Hytron before warehouse stockpiling. They are then ready to begin their journey through the varied manufacturing operations to the final steps of testing and packaging.

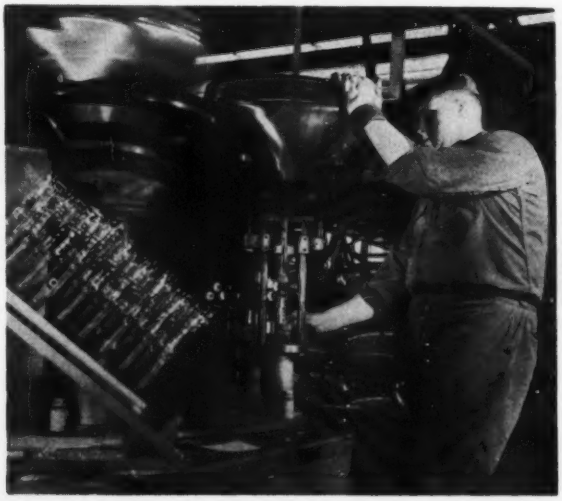
As scheduled for processing, the envelopes ride in an overhead conveyor first to the "bulb-prep" department, where they are loaded into a washing machine. Here they receive a hot caustic injection and a tap-water rinse. After a second injection—this time of dilute hydrofluoric acid followed by another water rinse—the bulbs travel to the "settling" or screening room.

At this point, one of the Kalamazoo production line's three especially built, electronically operated settling ma-

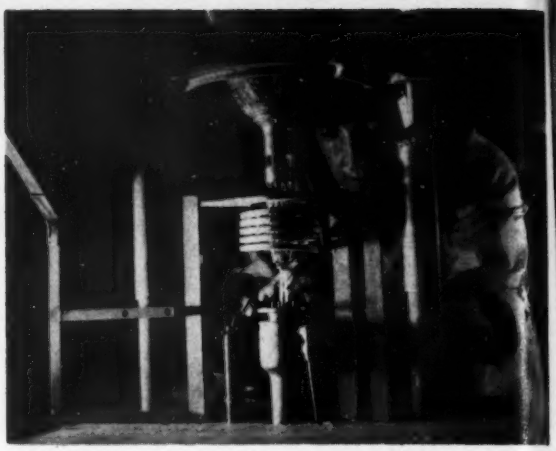
A three-man team aluminizing bulbs. Intense heat vaporizes an aluminum fragment which then spreads a thin, mirror-like metallic film over the phosphor screen.



Lining up the bulb's neck, with electron gun in stem, before the operation which seals it in.



Putting the stem with its electron gun into a holder preparatory to inserting the gun into the neck of the bulb.

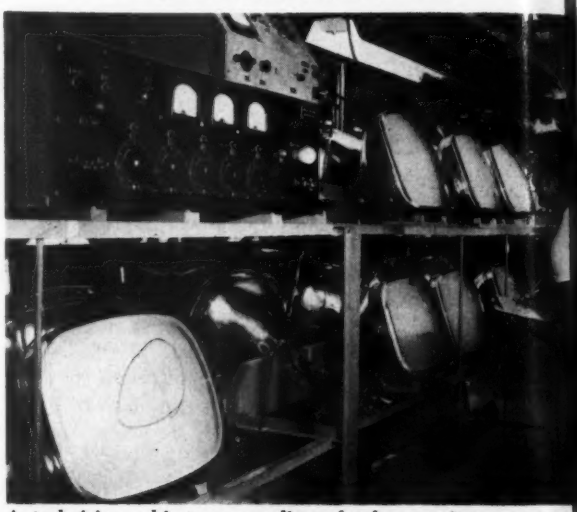


A sealed-in bulb is being fitted to a rubber clamp in an exhaust dolly. Wires are attached to electrodes in preparation for the later process of activating the cathode.

chines deposits a phosphor screen on the inside surface of each face-plate, where the television picture will eventually appear. Processing two bulbs simultaneously, each machine lowers injection pipes into the up-ended bulbs in order to partially fill them with chemically pure water, of which 120,000 gallons are demineralized each day in the plant's special water-treating equipment. The machine then adds phosphors to the water, mechanically agitating it to insure a thorough mixture. As the bulbs ride forward, two abreast in their saddles, the phosphors settle out of suspension and form a screen on the bulbs' inner faces. Now the remaining liquid is decanted from the bulbs. A drying process and a rigid inspection follow.

The next operation coats the inside of the face-plate with a lacquer which "fixes" the phosphor screen. After

(*Continued on page* 226)



A technician subjects a sampling of tubes to rigorous tests which will provide data for continuing improvement of CBS-Hytron tube performance.

Below right:

In a general, final inspection, this operator tests base pins for effective soldering, neck and base alignment and inside black band for even distribution.

Below:

Using a resistance arc, an operator welds the electron gun to the bulb stem.

Furnace Instrumentation Pays Dividends

● ARMSTRONG CORK COMPANY took over the old Whitall-Tatum Company glass plant at Millville, New Jersey, in 1938, and subsequently started a program of modernization that included a conversion from manual to automatic process control. Fully automatic production of glassware has never yet been accomplished, but the Armstrong engineers have brought many of the critical operations under automatic control. Features which the engineers like about their automatic control system are that erratic operation, slow drift away from standard, and human errors inherent in manual operation are eliminated.

Batch Charging

The charging of the batch into the melting furnace or glass tank is one of the most important unit processes. The modern system of automatic batch charging through the "doghouse" provides controlled distribution of batch from side to side in the tank by alternate operation of the batch chargers on each of the two sides of the triangular doghouse.

It is most important to control the rate of the charge of the batch into the tank in order to maintain the level of molten glass constant. The operation of the batch chargers is controlled so that the rate of charging of the batch exactly matches the rate of withdrawal of the molten glass to the forming machines at the front end of the tank.

The circular chart electronic controller mounted on the furnace panel-board is part of the system for measuring and controlling the level of the molten glass in the tank. This system includes a probe electrode which is periodically lowered and raised by a Hartford-Empire gaging unit, operated by a Beck reversing motor. Since molten glass is a conductor of electricity, the probe electrode will complete a circuit with the ground when the electrode contacts the surface of the molten glass. This circuit is detected by a Beck electronic relay that stops the motor from lowering the probe any further, and also signals the level to the electronic controller. This instrument controls a pneumatic operator with a positioner that regulates the charging of raw material to the tank. The recorder is graduated from plus one inch to minus one inch, and the glass level is controlled within plus or minus 0.01 inch.

Melting

The temperatures in the melting chamber get as high as 2840°F. The atmosphere of the furnace, particularly near the bridgewall and in the nose, must be oxidizing and must be free of carbon monoxide and carbon at all times since the presence of even a small percentage of carbon monoxide results in the formation of new bubbles or blisters.

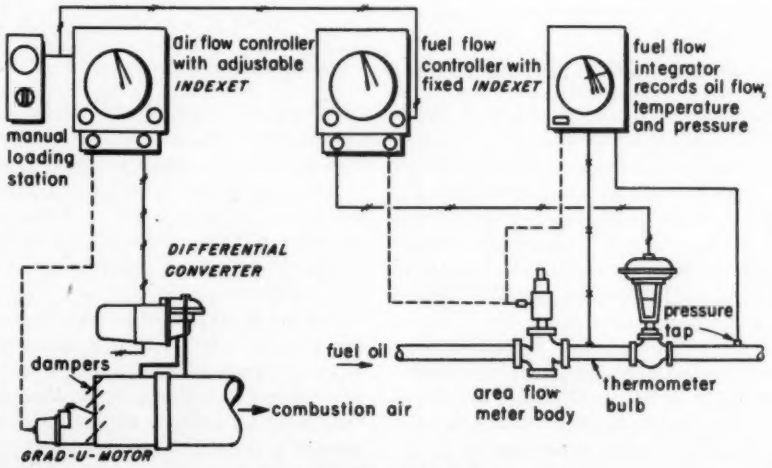
Armstrong Cork Company's Millville plant has five three-port glass tanks of the continuous melting Forter-Teichmann regenerative furnace design.

Fuel-Air Ratio Control

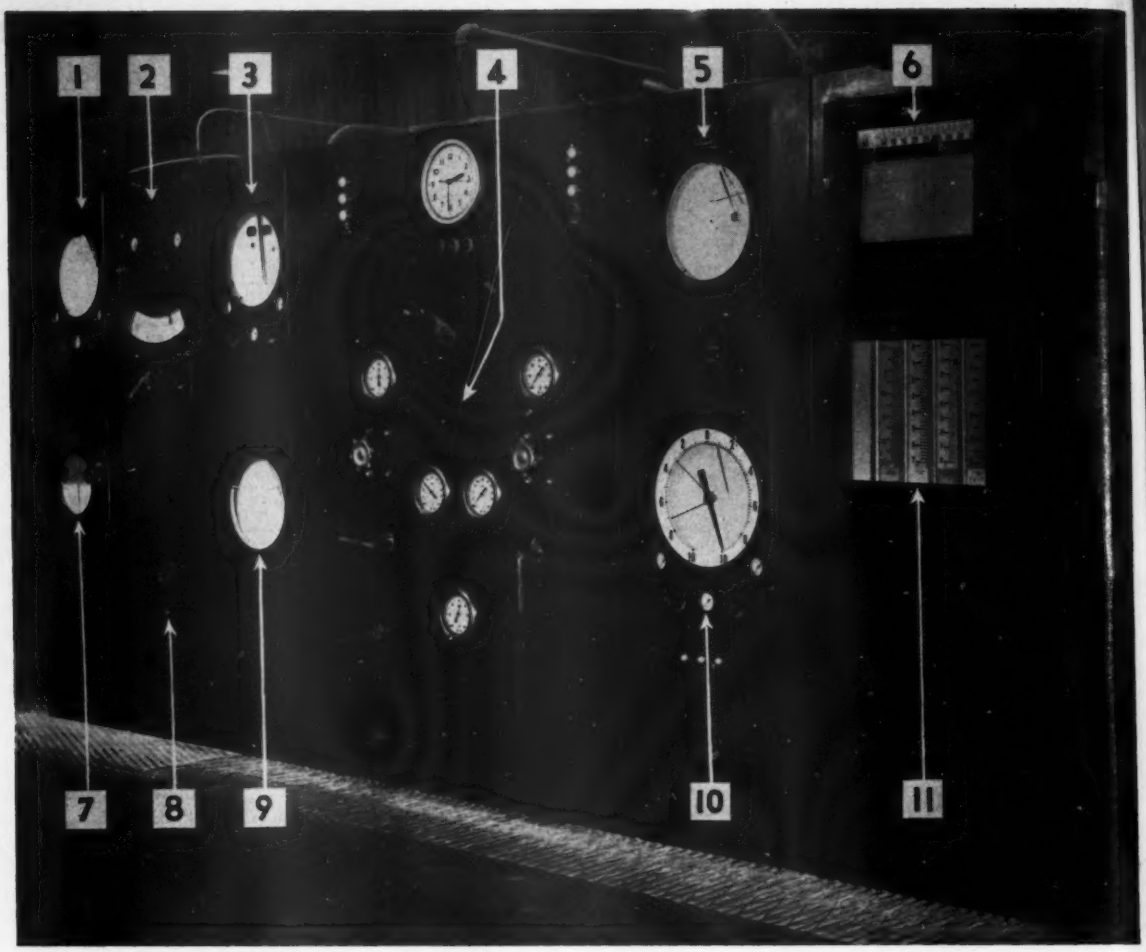
A fuel-air ratio control system is the outstanding feature of furnace control at the Millville plant.

Bunker C fuel oil is passed through a steam-heated exchanger and its temperature brought to about 210°F. This oil is atomized by compressed air in the burners at the furnace. A three-pen instrument records oil temperature, pressure on the downstream side of the flow control valve and oil flow, which it also integrates electronically. The flow-sensing element is a Brown area meter body which transmits electrical signals to the integrating recorder and also to the pneumatic controller that operates the diaphragm motor valve on the fuel line to the furnace. The set point index of the oil flow controller is moved up or down scale by an automatic index setting

Based on a story, by Roger F. Scott and William P. Bramlett of Armstrong Cork Company, which originally appeared in *Instrumentation*, house magazine of the Minneapolis-Honeywell Regulator Company.



Fuel-air ratio control system.



Main glass tank control panel, Armstrong Cork Company, Millville, N. J.

Left Section:

1—Recorder; combustion air flow controller (pneumatic control).

2—Indicator; furnace pressure controller (pneumatic controller, *but* operates an electric motorized valve).

3—Indicator; oil flow controller (pneumatic control).

7—Indicator; oil heater temperature controller.

8—Manual loading station where operator sets desired fuel-air ratio.

9—Recording-integrating oil flow meter, also equipped with temperature and recording pens.

Center Section:

4—Manual furnace reversal equipment, including necessary indicating gages, switches and signal lights.

Right Section:

5—Fuel oil pressure recorder with signal light.

6—Multiple record electronic tank temperature recorder.

10—Recording electronic glass level controller, pneumatic control. (Note that scale is graduated 10-0-10. This means —1 inch-0- +1 inch in glass level. Smallest chart division is 1/000 inch. Controller holds glass level to within ±1/100 inch. Controller can be equipped with chart and scale graduated 5-0-5 meaning —½ inch-0- ±½ inch.)

11—Indicating draft gages.

unit inside the instrument case. Air to this unit comes from a manual loading station on the panel.

The same air pressure from the manual loading station also operates an index setting unit mechanism in the combustion air flow controller. On this second unit are zero and span dials for changing the ratio of combustion air to fuel oil. This permits plant engineers to meet changing conditions of air infiltration into the furnace as it ages.

A blank space in the panel above the manual loading station awaits the day when analysis of oxygen content in the exit gases from the furnace will give better information on how to set the dial of the adjustable index setting unit for the most efficient ratio of air to oil.

Flow of combustion air is metered at an orifice plate in the pipe line and the differential pressure at the orifice is transmitted to the air flow controller whose index is set by the adjustable index setting unit. This instrument —in the upper left-hand corner of the furnace panel— controls a piston-type air operated unit which, with the aid of a pneumatic relay, operates louvre dampers that admit air to the fan which supplies the combustion air to the furnace.

Control of fuel oil supply to the furnace by flow metering is more accurate than by pressure measurement, but a pressure recorder with an electronic control unit is used to operate signal lights that inform the operator when burners coke up causing pressures in excess of 40 psi.

(*Continued on page* 232)

Some European Factories: Operation, Trends, History

By ALEXANDER SILVERMAN
University of Pittsburgh, Pittsburgh, Pa.

● IN CONNECTION with the meetings of the International Union of Pure and Applied Chemistry and the International Congress of Chemistry in Stockholm, Sweden, in 1953, the writer had the privilege of visiting a number of glass factories, museums and research laboratories. A brief account of observations follows.

France

Saint Gobain. On July 22, under the guidance of Director Ivan Peyches, there was a tour of the new research laboratories of chemistry and physics located at 52, Boulevard de la Villette, Paris XIX^{e}. This is about the most beautiful and the best equipped glass laboratory building the writer has ever had the privilege of seeing. Sitting in the Director's office and facing him at his desk, one sees, on the wall behind him, an attractive modernistic mural "La Ronde de l'Alchemie" by Max Ingrand, which portrays the history of glass from the beginnings through the modern atomic age. Other murals decorate the foyer and corridors. In the Conference Hall is a colored engraving on glass, "Le Maitre Verrier" by R. Passant, which symbolizes the many properties of glass from the plastic form to the crystal. Glass is utilized in all of its varied products for lighting, for construction, for diversified design. One is impressed with the completeness of the apparatus inventory. Everything is there; nothing is duplicated. There is the electron microscope, the finest bench for spectroscopy and and its recording, the last word in x-ray equipment, ovens and furnaces, devices for physical measurements. There is a huge laboratory, 40 or 50 feet high, for mechanical testing and experimentation, in which glass is subjected to conditions far beyond those encountered in actual use.

The Paris laboratory is the science clearing house for Saint Gobain. Samples of all kinds are sent by air-mail from the company's plants in other parts of France, and from affiliates in other European countries. They are transferred by messenger to the laboratory almost hourly.

The writer saw numerous new developments which he does not feel free to disclose. Although a new Saint Gobain-licensed electrically operated Borel window glass tank was viewed in Norway, French labor strikes regrettably made a return to Paris impossible the middle of August, thus interfering with visits to Saint Gobain's plate glass, optical glass and fiber glass factories. Highest commendation is due Director General R. Grandgeorge, Research Director Ivan Peyches and their associates.

Daum Freres. On July 23, after a three and one-half hour train ride west of Paris, the writer was met at Nancy in Alsace-Lorraine by Michel Daum, president of Cristallerie de Nancy, Daum. He was driven immediately to the Saint Christophe residence of the Michel Daums for luncheon. The gracious hospitality of M. and Mme. Daum and many others in Europe was very touching, an attitude that is appreciated and will never be forgotten. The Daum factory is engaged chiefly in the off-hand production of massive modernistic ware from rich lead crystal. While some lighter weight tableware is made, the tendency toward heavy ware has characterized Daum for half-a-century. The writer's collection, now at Alfred University, contains numerous specimens of the more formal early art, deeply etched in crystal, in colors and with gold-leaf interlayers.

Lalique. On July 24 the writer was met at Wingen by Marc Lalique, son of the late René Lalique, world famous for his art creations in glass. Under the guidance of Marc Lalique, a tour was made of the Lalique factory which has left indelible impressions. The present head of the firm is fully informed concerning every operation in its most minute details. He knows every employee and frequently stops to shake hands and chat with individuals. The consequent spirit of friendship and cooperation yields enviable results. The writer has never seen glass-making and decoration carried on to the degree of perfection encountered at Lalique. Every detail from the use of fuels, pot clays, raw materials for the glass, to the etching, grinding and polishing is the result of thorough study. Cutting of thin edges with diamond-dust suspensions in water, fed to copper wheels, is but a single example. There isn't a chip on one of these cut edges. The cutting suspension is recirculated to insure economy. Through careful selection and apportioning of pulverized raw and fired German and British clays, the pots yield a flawless rich lead crystal. If parts of an object are pressed, as in the Goddess of Rheims champagne goblets, every pressed-edge imperfection is ground away. Obviously the slogan of this factory is "Perfection."

The latter part of the morning, Marc Lalique drove the writer into the mountains to see the Verrerie de Goetzenbruck where small hand-blown cylinders, single and cased, in over 70 colors and tones are produced. The glass is used in sun-goggles, art windows, etc. and is melted in small day tanks, fired in a unique manner by oil sprayed down from the top and burning as it meets ascending air. In one of the tanks a beautiful selenium ruby glass was in production.

Thin small hand-blown cylinders are annealed in lehrs; the heavier ones in kilns. They are cracked off, split and flattened in the customary manner. The company operates a grinding and polishing department, but this was closed to visitors.

From Goetzenbruck, Marc Lalique drove the writer to Saint Louis les Bitche where the Cristalleries de St. Louis are located. In the absence of Director S. Clavel, who had been called to Paris, Associate Director Maurice Lepoire and Engineer Corbin conducted the writer through this most varied of all the art glass factories he has ever visited. A glasshouse is mentioned as early as 1586 in Münsthal (actually Saint Louis) in Lorraine. It was destroyed in the Thirty-Year War of 1618. In 1767, after the reunion of Lorraine with France, the factory was rechristened Verrerie Royale de Saint-Louis under letters patent issued March 4, 1767. In 1829 it became Compagnie des Cristalleries de Saint-Louis. In 1781-82 the French Academy of Science placed Saint-Louis in the forefront of the entire glass industry of France. The success was phenomenal. Four hundred workmen produced the finest crystal (there are more than 1000 today). The same pride in accomplishment exists today as in the beginning in this great family, every member of which has his heart and his soul in the job of perpetuating a precious tradition. In 1937 Saint-Louis received the Grand Prize at the International Exposition in Paris.

The products of Saint-Louis include filigré, millefiore, laticino, sculpture, engraving, etching, with a display of artistry and originality of design from the most delicate to the massive. There are the old millefiore paper weights, ranging from the early Venetian types through the most delicately chiselled porcelain relief of Queen Elizabeth set in an exquisite background of color and tasty ornamentation. Tableware ranges from heavy plain-cut beer tumblers and pitchers through lace-like wine glasses and their carafes. In cased and delicately cut wine glasses, only the Val Saint Lambert creations of Belgium can approach Saint-Louis. Their candle sticks and center pieces command awe and admiration. Cut massive crystal will match the finest from Sweden, though the latter excels in art engraving.

Denmark

Holmegaards Glasvaerk A/S. On the morning of July 28, progressive Arne Boas, Director of Holmegaards, drove the writer fifty miles south of Copenhagen, through one beautiful estate after another, to the factories in Holme-Olstrup, Zealand, founded in 1825, "the first glassworks in Denmark. Until 1814 Norway was united with Denmark, and on account of the great scarcity of fuel in Denmark, it was natural that glassworks built before that time should be placed in the large forests of Norway. After the Napoleonic wars, Denmark lost Norway and suddenly had no glassworks at all." A factory was then located on the "Holmegaard manorial estate owned by Countess Henriette Danneskiold-Lamsoe" where peat deposits occurred. The factory, though now a stock company, is under the presidency of Countess Elizabeth of Danneskiold, a charming and energetic young woman who has visited America a number of times and speaks a perfect English. Director Boas was educated and employed in the United States before taking over at Holmegaards recently. In 1827 the company began building houses "for officers, glassmakers and cutters" who still live rent-free in these attractive old cottages with their gardens. Even today all transportation takes place by road and there is no railway to the works.

The factory first produced bottles, then tableware, in small pot furnaces of which three containing six pots each are now operating, with adjoining cutting and decorating shops. The art work of Jacob E. Bang is internationally famous. Off-hand shops engage 70 workers and there are 36 cutters with an annual output of about 600 tons of tableware and artware of beauty and originality. There are three continuous tanks, two 10-ton and one 25-ton, equipped with modern bottle machines. The bottle output is about 5000 tons, but new plant construction will more than double this. About 600 workmen are employed in the bottle plants.

Sand, soda ash and most raw materials must be imported. After 1924 peat became too costly and coal was imported from England. During World War II they returned to peat but since then all furnaces have been oil-fired.

Sweden

Stockholm. In this attractive city on 23 bridged islands with numerous fjords, the International Union of Pure and Applied Chemistry was in session July 29 to August 3. The writer presided over the Commission on Inorganic Nomenclature whose tentative rules have since been published.

Among the many social functions scheduled was a reception at the Nobel Institute of Physics, and one by the City of Stockholm in the Town Hall. The walls of the great hall on the second floor are enormously tall (more than the equivalent of three normal floors) and the room is about a block long and fifty feet wide. The walls and ceiling are covered entirely with glass mosaics, most artistically and attractively applied. They depict history and legend, and portray noted persons, for example, Jenny Lind. They are the most extensive and elaborate mosaics the writer has ever seen in a single room.

Växjö. After a night-ride by "Pullman," the writer landed early on the morning of August 5 in Växjö, the center of the glass industry in southern Sweden. There he came under the wing of Bo Simmingsköld, the genial Director of The Glass Institute, which is not only a clearing house of the glass industry of Sweden, but is consulted by manufacturers throughout Scandinavia. There, researches are conducted on a laboratory scale. The sample cases show specimens of many types and colors. Raw materials are tested for member companies. *Glas Teknisk Tidskrift,* a monthly journal, is published under the editorship of Bo Simmingsköld. The Institute is young and located in small modest quarters, but has already accomplished much for the glass industry of Sweden and bears real promise.

Next, Bo Simmingsköld motored the writer to the Växjö Museum, where Swedish Art is usually on display. Unfortunately, the Museum was undergoing renovation, and much of the fine art was in storage. Fortunately, the residence of Edward Hald is an Orrefors Museum. One stands enraptured before these exquisite creations of Hald and his associates.

Kosta and *Orrefors.* Mr. Simmingsköld was then gracious enough to drive the writer south in his German Volkswagen, through forest roads lined with elms and birches and pines, to the hand operated factories of Kosta and Orrefors which employ the greatest artists and produce the most attractive art work of its kind in the world. Along the road we passed huge wagonloads of small-

diameter birch and elm logs. Inquiry elicited the information that they are used in the glass factories to make wood gas, much as we manufacture coal gas, for heating the furnaces. These are small and rectangular, usually holding two to six open pots. Propane, stored in great tanks carried on freight cars, also serves as fuel, especially for warming-in, cutting-off and glazing.

Rich lead crystal and colors yield perfect blanks from those open pots. For blocking, glass workers in Scandinavia use wet newspaper. What would be the equivalent of an 8 to 12 page section of our daily papers is folded and refolded until it is about 10 inches square and a quarter to three-eighths of an inch thick. These wet packs are stored in stacks about a foot high and drawn upon as required. A wet pack is placed in the palm of the hand and used for blocking and shaping the blown gather from time to time. Interestingly enough, neither the steam nor the heat bothers the workmen who do not wear gloves. The question "why is paper-blocking not in general use in other parts of the world?" elicited the amusing reply, "Because you do not have Swedish newspapers." Certainly the procedure affords more flexibility in blocking than do charred wooden forms.

At Orrefors, on July 8, the writer enjoyed the hospitality and personal guidance of Edward Hald, the master who is noted for his "Graalglas." "Graalglas" consists of an original gather of crystal over which a thin layer of gold ruby, or preferably purple, is usually gathered. The mass is allowed to cool slowly in a kiln and is then covered with resist. The design is sketched through the resist, then etched with acid. The resist is melted off in hot water, and then the dried hot gob or partly blown bulb is gradually heated up in an oven, reattached to a blow pipe, covered with another layer of crystal, given its final shape and then annealed. Edward Hald seemed quite astonished when the writer had deduced the method of making "Graalglas," a deduction arrived at many years ago when he acquired several specimens for his "collection of modern glass." One of these, Angel Fish, is an exquisite example of Hald's superb art. At Orrefors, also, for many years, was the late Simon Gate, master engraver of Sweden. His engravings are unsurpassed. The writer well recalls having paid $250 for an engraved whisky bottle during "Prohibition." Yes, it was empty. It was only a modest example of Gate's art.

The lives and work of both artists are recorded in a beautifully illustrated 175-page volume, "Simon Gate—Edward Hald" published in Sweden in 1948. Edward Hald graciously inscribed a copy and presented it on the occasion of the writer's visit to Orrefors.

But Orrefors also manufactures less costly glass than that referred to above. Many a home has examples of the sample perfume bottles, vases, etc.

Associated with Hald and Gate was Vicke Linstrand, now Director of Art of Kosta, where he has been stationed during the last decade. This tall graceful athlete has not only inherited the art of his tutors, but has initiated instructive art principles of his own. Perhaps the most impressive of this art is his "line work" in which fishermen with their nets and catch are portrayed in living line drawings. Of course there are numerous other themes.

Kosta makes a great variety of heavy off-hand crystal, and crystal with colored borders and handles. The lighter cut tableware and vases are noted for their unusual design. There are engravings, also.

Numerous small plants dot the south of Sweden, but unfortunately time limited the visits to Orrefors and Kosta.

Göteborg. A rail trip from Växjö to Göteborg, and we visit Professor J. A. Hedvall's Laboratory of Silicate Chemistry in Chalmers University of Technology. Unfortunately, Professor Hedvall was on his vacation. The Institute, located on an attractive hillside, and housed substantially, has well-equipped laboratories for all phases of silicate research. There are over 400 research publications, most of them authored or co-authored by Professor Hedvall.

Norway

Oslo. A short flight from Göteborg brings us to Oslo, center of the Norwegian glass and chemical industry. But the City has other places of interest. Before going to the glass plants, let us take a glance at the Olympic ski-jump and look into the valleys and at the fjords of Oslo; then we go to the Viking Museum to see almost complete original galleys of the type used by the Norsemen in their voyages to North America in pre-Columbus times; next to the Viglund Museum of Sculpture, outdoors, really an extensive park which challenges the endurance of the most sturdy hiker. The sculptures of men and women of gigantic stature, in stone and in bronze, portray every human emotion. They have had world-wide discussion, were portrayed in *Life Magazine* some years ago. The sculptor's iron gates, that tower-of-life in light gray stone rising skyward, all leave indelible impressions.

And now for the glass plants. In the absence of Ragnar Tanberg, President of Drammens Glasvaerk, Finn Djesmoe, Supervising Engineer of the company, took the writer in tow, placing a car and chauffeur at his command. Mr. Djesmoe accompanied the visitor almost everywhere during the Oslo visit. At Drammen, a two-hour drive from Oslo, is the window glass factory where the Fourcault process is in operation in adjoining buildings, one housing an all-electric 100 volt screw-connector graphite-electrode tank licensed by Saint Gobain, the other a producer gas-fired plant. The electric furnace is a thing of beauty, clean, easily controlled in all parts of the tank (melting, refining, drawing). However, the quality of the glass (single and double strength) did not seem any better than that from the gas-fired furnace. Not far from the window glass factories is a large mechanically operated bottle plant which the writer did not have time to visit. The five-day week is not observed as closely as in America; these visits were made of a Saturday morning.

Nitrogen Fixation: Notodden, Rjukan. The Norwegian is a tireless individual. Although arriving in Oslo on a Friday evening, and visiting Drammen, and sight-seeing in Oslo all of Saturday afternoon and well into the evening, Sunday saw us (Mr. Djesmoe, the writer and chauffeur) driving for several hours over narrow rugged mountain passes to Notodden, home of the original nitrogen fixation from air by Birkeland and Eyde, almost half-a-century ago. This little town in the river valley was under a cloud of fog and smoke. Thence, to Rjukan (half-way between Oslo on the east coast and Bergen on the west coast), a small town entirely surrounded by high mountains, where Norsk-Hydro is located. The Rjukan Falls were originally the highest and largest in Norway. Today there is a huge lake (reservoir) on the Hardanger Vidda plateau at the 5000 foot level and another at the 3000

foot level. Water from these enters pipe lines for power generation. Norsk-Hydro is reputed to have the largest hydroelectric plant in the world. No signs of the original waterfall are in evidence; its drop is entirely in pipe lines. We ascended in a funicular tramway on a single cable to the top of the mountain to get a view of the gigantic chemical layout in the valley. Later we were driven on a single-lane road to lunch at the top level.

There are innumerable electrolyzing units for preparing hydrogen and oxygen, flat (vertical) circular cells whose diameters must be at least ten feet. Then there are the units which produce caustic soda and chlorine from salt. It is here that heavy water accumulates in the largest unit of its kind in the world, yielding a deuterium oxide of a purity of 99.28% or higher. It is a matter of interest that large quantities of heavy water were produced and stored prior to World War II at Norsk-Hydro. Interesting to state, also, is the fact that the engineer, who toured the company plants with the writer, was the very man who, under cover of darkness, entered the heavy-water plant with several companions and blew it up to prevent the Nazi occupants from shipping deuterium oxide to Germany. Several boats, already loaded with heavy water for transport, were also blown up. The Germans wanted it for nuclear fission work. Norsk-Hydro has the largest hydrogen plant in the world.

Among the Norsk-Hydro products that may interest glassmakers are nitrate of lime, ammonium nitrate limestone, ammonium nitrate dolomite, niter, ammonium sulfate, soda ash. Of these, nitrate of lime is already employed by some European glass manufacturers in place of niter. Calcium nitrate melts at 561°C; sodium nitrate at only 305.5°C. The nitrate in use in European factories and now available in America, analyses:

Calcium Nitrate	80.40%
Magnesium Nitrate	1.50%
Strontium Nitrate	0.20%
Ammonium Nitrate	4.75%
Water	13.15%

The ammonium nitrate may serve as an additional fining agent. It decomposes at 230°C.

Another seven-hour drive over those rugged mountain passes and back in Oslo about midnight, the culmination of the visit to one of Norway's vast electrochemical industries, probably the most important one. And lest we forget, Norwegian glass plants use oxygen-hydrogen flames for burning off their ware.

Next morning another two-hour drive to Hadeland Glassvaerk, where off-hand shops produce household and art ware. Except for the electric-furnace unit in Drammen, Hadeland, situated on a lumber fjord, probably has the most modern accessories of any Norwegian glass factory. The plant includes dining and social assembly facilities that are second to none in America. The plant is replete with off-hand shops, but the products are not as artistic as some of the Swedish, the Dutch or the French, and the prices are high.

Another flight, Oslo to Amsterdam, and a return to the ever attractive canals of Holland. An hour by rail from Amsterdam, through Utrecht, and we reach Leerdam with its glassworks and museum. Leerdam resembles the Saint Louis factory of France, but goes even farther in variety for it includes bottle manufacture and the use of automatic machinery. Thick cast plates of artistic design remind one of Baccarat; engravings, of Alsace-Lorraine. Heavy colored interlayer patterns in massive crystal vases by Copier and his associates differ from the work of Edward Hald in that they are laid on and designed by the hand of artisan and artist. They are full of action. The most impressive designs are in black overlaid by crystal.

We dare not close the Leerdam picture without a special reference to designer W. Heesen who was the writer's host and personal guide during his visit to the factory and museum. Like Vicke Linstrand of Kosta, Heesen creates diamond-cut line drawings and designs. In Heesen's case, clear cullet chunks of various sizes and shapes are annealed and then decorated in a manner and design best suited to each surface. The ensemble is a work of art and, of course, each objet d'art is different from all the others. Some of his outstanding creations are in the Leerdam Museum. His art is in great demand among connoisseurs.

The new Glass Museum had just opened. It is a treasure house of Leerdam art, displaying the glass creations of Copier, the late Lanooy, etc. There, also, was the bowl engraved by our master-engraver, Sidney Waugh of Corning, and sent as a gift to Wilhelmina on her 50th anniversary as Queen of Holland by President and Mrs. Harry S. Truman. The decorative theme, "Stephen Foster," naturally appealed to a Pittsburgher.

The tour should have included visits to N. V. Kristalunie Maastricht, in Maastricht, Holland, and Cristalleries du Val-Saint-Lambert, in Liege, Belgium, both of which produce beautiful art glass and dinner ware. They had closed for vacations, as most European factories do. The return to Paris would have included visits to Parra-Mantois, the optical plant of Saint Gobain, and to the company's fiber glass, plate glass and window glass plants. The French communications and transportation strikes made these plans impossible.

Economic Data

Some of the European manufacturers, whose plants were so graciously opened to the writer, have even been kind enough to furnish information for a comparative study of their "off-hand" labor and other costs. Reference will be made to countries, but not to individual factories. The report follows:

All values in U. S. dollars

Hourly Wages	Denmark	France	Holland	Norway	Sweden
Head of Shop					.66 to .70
Furnace-room helpers, batch-makers, etc.				.60	.46 to .65
Gatherers			.56	.64	.44 to .59
Warming in boys					.44
Blowers	.62	.72	.56	.73	.62
Stem makers					.52 to .59
Carrying-in boys	.22	.34		.31 to .63	.28 to .40
Apprentices	.39				
Cutters	.60	.69	.54	.69 to .80	.64 to .74
Engravers		.57	.76		.70 to .73
Mold makers					.65
Potmakers					.71
Smiths	.67				
Unskilled Labor	.45		.44		
Women	.30				
Shift bonus 7 p.m. to 10 p.m.					.025
Shift bonus 10 p.m. to 6 a.m.					.068

Housing and Rentals. In Denmark there is an annual

(*Continued on page* 224)

Inventions and Inventors

Annealing and Tempering

Method and Apparatus for Tempering Glass. Fig. 1. Patent No. 2,690,629. Filed February 10, 1947. Issued October 5, 1954. Two sheets of drawings. Assigned to The American Securit Company by Jean R. A. Prachay.

It has been found that thin plates may be successfully tempered by employing air at a somewhat higher pressure than the practice formerly employed and issuing it from long nozzles of relatively small diameter terminating relatively close to the sheet and close to each other, while leaving ample area for the escape of heated air from the surface of the plate between such surface and the face of the blast box from which the nozzles project.

In Fig. 1 a construction is shown in which the box is moved as a whole, it being mounted on the rods 8 guided in the packing boxes 10. The rear plate of the box is connected by the piston 16a with a piston head 16 working in an air cylinder 15. A suitable pipe 18 is provided for supplying air under pressure to the cylinder 15 from the distributing box 17 and from the same distributing box, a plurality of pipes is provided letting air into the blast box, the cross-sectional area of the pipe 17 being such that the piston head 16 will be shifted to the limit of its movement prior to the building up of pressure in the blast box. The admission of air to the blast box is accompanied by a simultaneous or prior motion of the nozzles towards the sheet to be tempered, thus supplying a blast of air to the nozzles when, and only when, they are at the proper distance from the sheet.

The patent contains 9 claims and the following references were cited: 1,895,548, Lebel, Jan. 31, 1933; 1,970,730, Black, Aug. 21, 1934; 2,131,406, Mosmieri et al., Sept. 27, 1938; 2,235,969, White, Mar. 25, 1941; 2,251,159, Owen, July 29, 1941; 2,259,727, Bowers, Oct. 21, 1941; 2,263,679, Ferre, Nov. 25, 1941; and 916,498, France, Aug. 19, 1946.

Feeding and Forming

Glass Bending Apparatus. Fig. 2. Patent No. 2,688,210. Filed March 10, 1953. Issued September 7, 1954. Two sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by J. E. Jendrisak.

This invention relates to an improved bending mold having a shaping surface of the type which conforms to the curvature and in outline to a bent glass sheet. A primary object of this invention is to provide an improved apparatus for bending glass sheets whereby mold marks on the margins of the sheet are substantially eliminated.

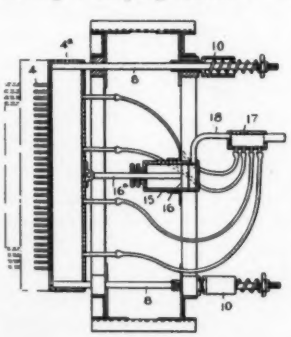


Fig. 1.

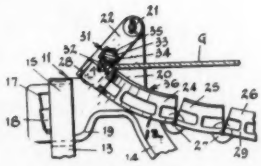


Fig. 2.

Mold 12 in Fig. 2 comprises end sections 24, intermediate sections 25 and a center section 26. Hinges 27 serve to connect the end sections 24 to the intermediate sections 25 and the latter to center section 26. The molds are finished in such a manner that when the mold is closed, they are in abutting relation and further closing movement of the mold is positively prevented. It can be seen that the mold 12 can be swung on links 22 to its open position for supporting a flat glass sheet G (Fig. 2) and will be maintained in that position by the strut-like nature of the flat sheet. However, as the sheet is softened by heating during passage of the mold through a furnace, it will gradually lose its strut-like character and bend to the curvature of the mold at which time the mold will move to its closed position.

The patent contains 12 claims and the following references were cited: 2,633,673, Bamford et al., Apr. 7, 1953 and 681,943, Great Britain, Oct. 29, 1952.

Glass Edge Working Machine. Patent No. 2,688,214. Filed June 15, 1949. Issued September 7, 1954. Eight sheets of drawings (none reproduced). Assigned to Libbey-Owens-Ford Glass Company by J. C. Ogle and J. F. Jordan.

Details of an improved edge-grinding machine are shown. The machine is specially designed for the edging of glass mirror plates which are used in the manufacture of rear view mirrors for automobiles. The machine comprises a rotary work holder of a vertically stationary support block and rotary grinding wheel for grinding the edges of the work piece. A vacuum control operated by the workman provides a vertically movable means for raising the finished work piece from the work holder and for subsequently lowering a rough work piece into position for grinding. The novel controls permit the edging and beveling of glass plates rapidly, accurately, economically, and with a minimum of handling and a minimum amount of effort and attention on the part of the operator. The detailed operation of the machine is best understood by examination of the numerous complicated drawings.

The patent contains 10 claims and 19 references were cited.

Method and Apparatus for Forming Glass Parisons. Fig. 3. Patent No. 2,688,823. Filed November 20, 1950. Issued September 14, 1954. Three sheets of drawings. Assigned to Owens-Illinois Glass Company by Walter C. Weber.

An object of the present invention is to provide a method whereby, in the expansion of a parison to final form, the distribution of glass in all the various wall sections of the finally formed article may be regulated and controlled as desired. In the formation of a parison by this method, a charge of molten glass is fed into the parison mold 10. Plunger 12 is moved down under controlled pressure into contact with the molten glass, thereby

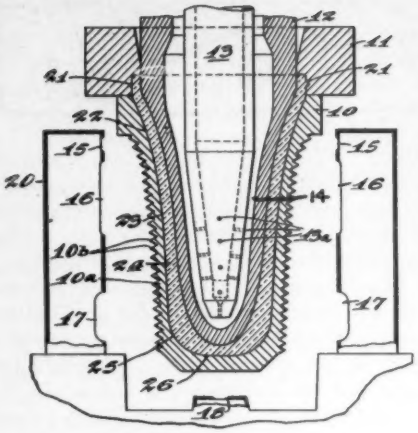


Fig. 3.

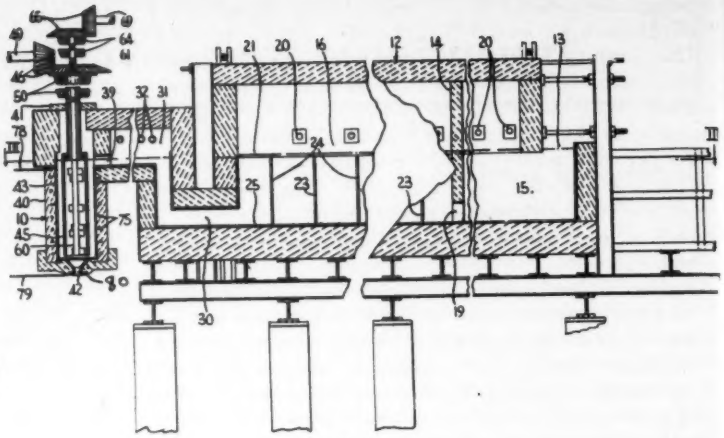


Fig. 4.

forcing it into the outer confines of the parison mold 10 and neck mold 11 to form the shaped parison 14.

Plunger 12 is provided with an internal cooling nozzle 13 through which a flow of cooling air is provided internally of the plunger. The flow may be of a type to provide either an equalized or a zonal chilling of the glass coming into contact with the external surface of the plunger 12 by arranging openings 13a in any desired pattern and air volume. Thus the vertical flow of heat in the walls of the plunger 12 may be regulated and controlled to control the pattern of chill imparted to the glass.

Air nozzle openings 15, 16, 17 and 18 are indicated and shown positioned in the manner required for obtaining the desirable predetermined pattern of chill in the parison mold and parison for the specific container illustrated. The basic theory of pattern cooling remains the same, i.e., the total surface area of the parison is cooled, both inside and outside, with such cooling being regulated and controlled throughout the total surface area in accordance with shape and size of the finished container and for obtaining both control of expansion and the ultimate in strength, particularly in lightweight ware.

The patent contains 5 claims and the following references were cited: 1,057,198, Winder, Mar. 25, 1913; 1,633,028, La France, June 21, 1927; 1,798,136, Barker, Jr., Mar. 31, 1931; 1,800,191, Lorenz, Apr. 7, 1931; 1,865,967, Schoonenberg, July 5, 1932; 2,269,553, Roessler, Jan. 13, 1942; 2,336,821, Wadman, Dec. 14, 1943; and 2,402,475, Waterbury et al., June 18, 1946.

Furnaces

Method and Apparatus for Refining Molten Glass. Fig. 4. Patent No. 2,688,469. Filed November 1, 1951. Issued September 7, 1954. Three sheets of drawings. Assigned to Pittsburgh Plate Glass Company by F. R. Hohmann.

This invention relates to the refining of molten glass to produce optimum homogenization, and it has particular relation to a stirring or mixing mechanism designed to effect such homogenization.

In the refining chamber 16, Fig. 4, molten glass is directed along an irregular or sinuous path by means of upright baffles 23 and 24 placed transversely of the chamber 16 and across the direction of flow of the molten glass. The baffles themselves, and a lining 25 in which the baffles are mounted for containing the molten glass, are composed of highly resistant metal, such as platinum. Alternate baffles 23 and 24 are formed with upper openings 26 (not shown) and lower openings 27 (not shown), respectively, so that the glass passes upwardly and through the openings 26, thence downwardly and through the lower openings 27. The glass is directed through a relatively narrow passage 30 from which the glass enters a conditioning chamber 31 in which the temperature of the glass is uniformly controlled. This chamber is provided with so-called glow bars 32 constituting resistance elements through which electric current is passed from electric supply mains. Molten glass passes from the conditioning chamber 31 into a passage 39 leading to the homogenizing unit 10. In order that the glass may be maintained at such consistency as to be properly responsive to the stirring action in the homogenizer, the heating coils 75 are energized so that the molten glass, while being subjected to the stirring action, is maintained at a temperature of approximately 2250°F. to 2500°F. Molten glass at such high temperatures is not properly adapted to be fed to a gobbing machine because it flows too freely. Therefore, the temperature of the glass is reduced materially before it is discharged from the lower end of the tubular outlet 42. It is desirable to employ a tubular outlet 42 sufficiently long to insure reduction of the temperature therein from 2250°-2500°F. to 1900°-2000°F.

The patent contains 7 claims and 10 references were cited.

Glass Melting Tank. Fig. 5. Patent No. 2,689,433. Filed May 12, 1952. Issued September 21, 1954. Five sheets of

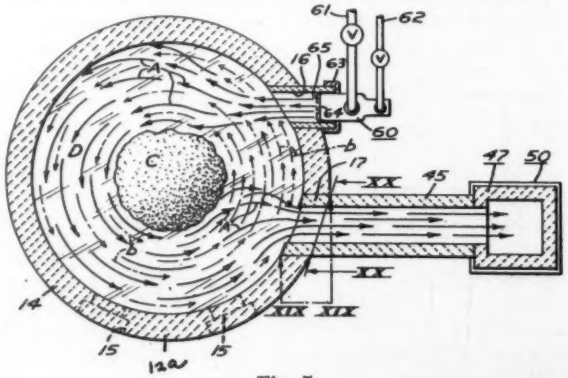


Fig. 5.

drawings. Assigned to The Phoenix Glass Company by W. N. Mathews.

This invention relates to a new and improved glass melting tank construction and particularly to a round tank suitable for so-called "day" usage. In Fig. 5 the batch charge to be melted is indicated as C and the melted glass as D. The full line arrows A indicate the path of movement of the burning combustion gases from the burner about the tank to the stack, while the dot and dash arrows B indicate the corresponding stream movement of the melted glass D.

A proportional burner is shown having a housing 60, air and gas inlets 61 and 62, a mounting flange 63 and a burner head 64. The head 64 is provided with a series of air outlets 66 (not shown) in its front face and a series of radially-outwardly extending and peripherally spaced-apart gas tube spokes 65. The flame is directed so that it strikes the centrally-positioned charge C and is diverted outwardly towards the inside of the flux tier of the furnace to move in a circular path thereabout. This arrangement is highly effective since the flame is not pointed tangentially or directly towards the wall blocks but, on the other hand, is initially directed on a dissecting longitudinal plane towards an opposite wall segment of the tank. However, the flame is diverted during its movement so that it actually moves in an encircling path about the inside of the tank with a minimum of wear and tear on the wall blocks, with a maximum effectiveness of melting down action upon the cullet or batch C, and in such a manner that full combustion is accomplished before it enters the flue connector construction 45. The work holes in the blocks 15 may be closed off during the heating up operation and then opened during the holding cycle to permit molten glass to be removed from the wall 12a as needed. This novel furnace is said to be more flexible, economical and provide more homogeneous glass.

The patent contains 6 claims and the following references were cited: 230,668, Siemens, Aug. 3, 1880; 270,594, Leuffgen, Jan. 16, 1883; 908,151, Schwenzfeier, Dec. 29, 1908; 1,032,177, Baillie, July 9, 1912; 2,263,348, Keaney, Nov. 25, 1941; and 753,472, France, Aug. 7, 1933.

Glass Compositions

Fluorescent Screen of a Phosphor in Glass and Method for Producing Same. Patent No. 2,689,188. Filed December 12, 1950. Issued September 14, 1954. One sheet of drawings (none reproduced). Assigned to Westinghouse Electric Corporation by Walter J. Hushley.

A method of forming a phosphor screen is presented. An X-ray phosphor, such as zinc sulphide, is embedded in a transparent glass matrix in which the phosphor is completely enclosed beneath the glass surface. A suitable glass composition for the matrix used was as follows: silica, 20; alumina, 3; magnesia, 2; lithium oxide, 2; sodium oxide, 5; potassium oxide, 2; boric oxide, 66. The embedding glass is ground to a powder capable of passing through 150-mesh. It is then mixed with approximately equal weight of an X-ray phosphor powder, such as zinc sulphide, which has particle sizes averaging about 20 microns. This mixture is then deposited evenly to a thickness of about 100 mg. per square centimeter on a supporting glass.

The patent contains 4 claims and the following references were cited: 1,364,951, O'Hara, Jan. 11, 1921; 2,049,765, Fischer, Aug. 4, 1936; 2,094,630, Winninghoff, Oct. 5, 1937; 2,123,939, Germer, July 19, 1938; 2,238,784, Scott et al., Apr. 15, 1941; 2,439,192, Sun et al., Apr. 6, 1948; 2,573,200, Hushley, Oct. 30, 1951; and 606, 819, Great Britain, Aug. 20, 1948.

Eye-Protective Ophthalmic Glass. Patent No. 2,688,559. Filed April 27, 1953. Issued September 7, 1954. No drawings. Assigned to Corning Glass Works by W. H. Armistead.

This invention relates to neutral or gray-colored ophthalmic glasses having substantial absorption for infrared and ultraviolet as well as visible radiations. Infrared and ultraviolet radiations are effectively absorbed by glasses containing FeO and Fe_2O_3, respectively, and these oxides are commonly utilized in glasses for these purposes. The inclusion of TiO_2 in such a glass provides control of the hue of its greenish complement and thereby of the desired neutral color. Variations in the reducing conditions can be readily tolerated without the production of any deleterious effects.

The following glass compositions calculated from their respective batches to the oxide basis in parts by weight are illustrative of desirable glasses:

	1	2	3	4	5
SiO_2	56	65.6	63.6	57.5	61
K_2O	17	20	20	17	17
Na_2O	—	—	—	3	8
Li_2O	—	—	2	—	—
BaO	25	—	—	20	—
CaO	—	12	8	—	—
MgO	—	—	4	—	—
Al_2O_3	—	—	—	—	12
$FeO + Fe_2O_3$ (Computed as Fe_2O_3)	1	2	2	1.5	1
TiO_2	1	0.4	0.4	1	1
NiO	0.10	0.20	0.20	0.15	0.10

The patent contains 14 claims and no references.

Eye-Protective Ophthalmic Glass. Patent No. 2,688,560. Filed April 27, 1953. Issued September 7, 1954. No drawings. Assigned to Corning Glass Works by W. H. Armistead.

New neutral-colored glasses for ophthalmic purposes are reduced glasses which comprise essentially 50 to 75% SiO_2, 14 to 23% K_2O, and up to 25% ZnO, and contain glass-coloring components consisting of FeO and Fe_2O_3 totalling 0.3% to 4.5% computed as Fe_2O_3, 0.1% to 2% TiO_2, and 0.02% to 0.50% NiO, the ratio of the computed Fe_2O_3/NiO being 5/1 to 15/1, the essential constituents totalling at least 75. Preferably, the amount of K_2O does not exceed 20%. B_2O_3 is also a glass-stabilizing oxide. It can be alternatively included as an essential ingredient in the present compositions, provided that it does not exceed 20% and provided that the total of ZnO and B_2O_3, if both are present, does not exceed 30%. If desired, auxiliary glass-stabilizing oxides, namely, up to 12% BeO, up to 15% MgO, up to 20% CaO but not over 20% of MgO + CaO, up to 25% SrO, up to 25% CdO, up to 25% BaO, up to 15% Al_2O_3 and up to 10% ZrO_2, can optionally be included, singly or in combination, within the indicated amounts in the present glass compositions provided that their total does not exceed 25%.

The patent contains 14 claims and no references were cited.

Eye-Protective Ophthalmic Glass. Patent No. 2,688,561. Filed April 27, 1953. Issued September 7, 1954. No drawings. Assigned to Corning Glass Works by W. H. Armistead.

This invention relates to neutral or gray-colored ophthalmic crown glasses having substantial absorption for infrared and ultraviolet as well as visible radiations. They have the optical and physical properties which characterize white spectacle crown and have come to be accepted as a standard in the trade, whereby such glasses are particularly suitable for use in eye-corrective lenses. Such optical and physical properties, as is well known, include a refractive index of 1.523 ± 0.001, an expansion coefficient of about 92 to 98 x 10^{-7} per °C. (between 0° and 300°C.), and a softening point between about 710° and 735°C. (By softening point is meant that temperature at which the viscosity of the glass is $10^{7.6}$ poises.) Typical glasses are shown as follows:

	1	2	3	4	5	6	7	8
SiO_2	65.3	67.6	66.2	65	66	65.6	63.4	68.6
K_2O	11.4	12	10	11	13.6	18	11	14
Na_2O	7.0	7	7	6	4	—	8	4
Li_2O	—	—	—	—	1	3	—	1
ZnO	11.1	6	15	13	10	6	9	6
Al_2O_3	2.0	2	—	—	2	2	2	—
B_2O_3	—	—	—	2	—	—	5	—
ZrO	—	—	—	—	—	—	—	3
CaO	—	—	—	2	—	—	—	—
$FeO+Fe_2O_3$ (Computed as Fe_2O_3)	2.1	3.6	1.2	0.7	2.2	3.6	1	2.2
TiO_2	0.9	1.5	0.5	0.3	1	1.5	0.5	1
NiO	0.18	0.33	0.10	0.05	0.22	0.33	0.10	0.20

The patent contains 8 claims and no references were cited.

Sheet and Plate Glass

Sealing a Rectangular Glass Panel into a Rectangular Metal Frame. Fig. 6. Patent No. 2,686,390. Filed April 16, 1952. Issued August 17, 1954. One sheet of drawings. Assigned to Radio Corporation of America by Bernard J. Williams and Richard H. Hughes.

Sealing flames are provided from a plurality of burners 24, which are arranged in a circle on a circular frame 26. The burners are all directed toward the center of the circular frame 26. The metal envelope 10 is mounted at the center of the circular frame 26 with the plane of flange 18 perpendicular to the axis of the circular frame 26 and with the axis of the envelope 10 at the center of the circular frame 26. Furthermore, the tubular envelope 10 is positioned along the vertical axis so that the plane of the flange 18 is somewhat above the plane of the circular frame 26, and so that the flames of the burners 24 may be directed upwardly against the lower surface of the flange portion 20. The face plate 16 is laid on the sealing land 20 of the flange 18 prior to sealing as shown in Fig. 6. During the sealing process, the envelope is rotated at substantially 44 R.P.M. about its axis.

The patent contains 6 claims and the following references were cited: 2,237,186, Malloy, Apr. 1, 1941; 2,361,824, Dorman, Dec. 31, 1944; 2,573,266, Melcher et al., Oct. 30, 1951; and 536,858, Great Britain, May 29, 1941.

Miscellaneous Processes

Method of Producing Light Refracting Optical Elements Having Aspherically Curved Optical Interfaces. Fig. 7. Patent No. 2,685,821. Filed September 25, 1951. Issued August 10, 1954. Six sheets of drawings. Assigned to American Optical Company by E. D. Tillyer and A. H. Bennett.

The present invention relates to objectives of which typical examples are lens systems used as objectives in the photographic field for producing an image either on a film (as in a camera) or on a screen (as in a projector), and lens systems used as microscope objectives and telescope objectives. This application is a division of Patent No. 2,596,799.

An example of how the invention may be applied is illustrated in Fig. 7. A simple system consists of two lenses for power, uncorrected for color and designated respectively 5 and 8. This system has very pronounced spherical aberration. Into the system is introduced a crown-flint meniscus 6, 7 of substantially no power, the meniscus 6, 7 perfectly being positioned near the stop of the system. Member 6, 7 may be made in various ways. For instance, the flint element 6 may be ground with an aspheric surface 6a complemental to the surface 7a of the crown element 7, and the two elements cemented together. It is preferable, however, to produce the aspheric sur-

(*Continued on page* 233)

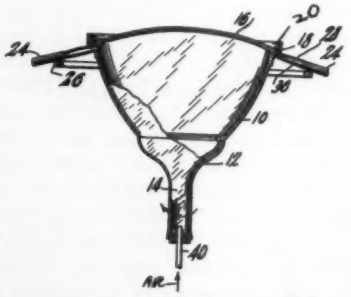


Fig. 6.

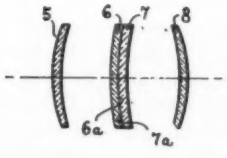


Fig. 7.

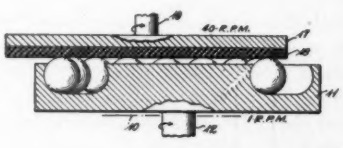
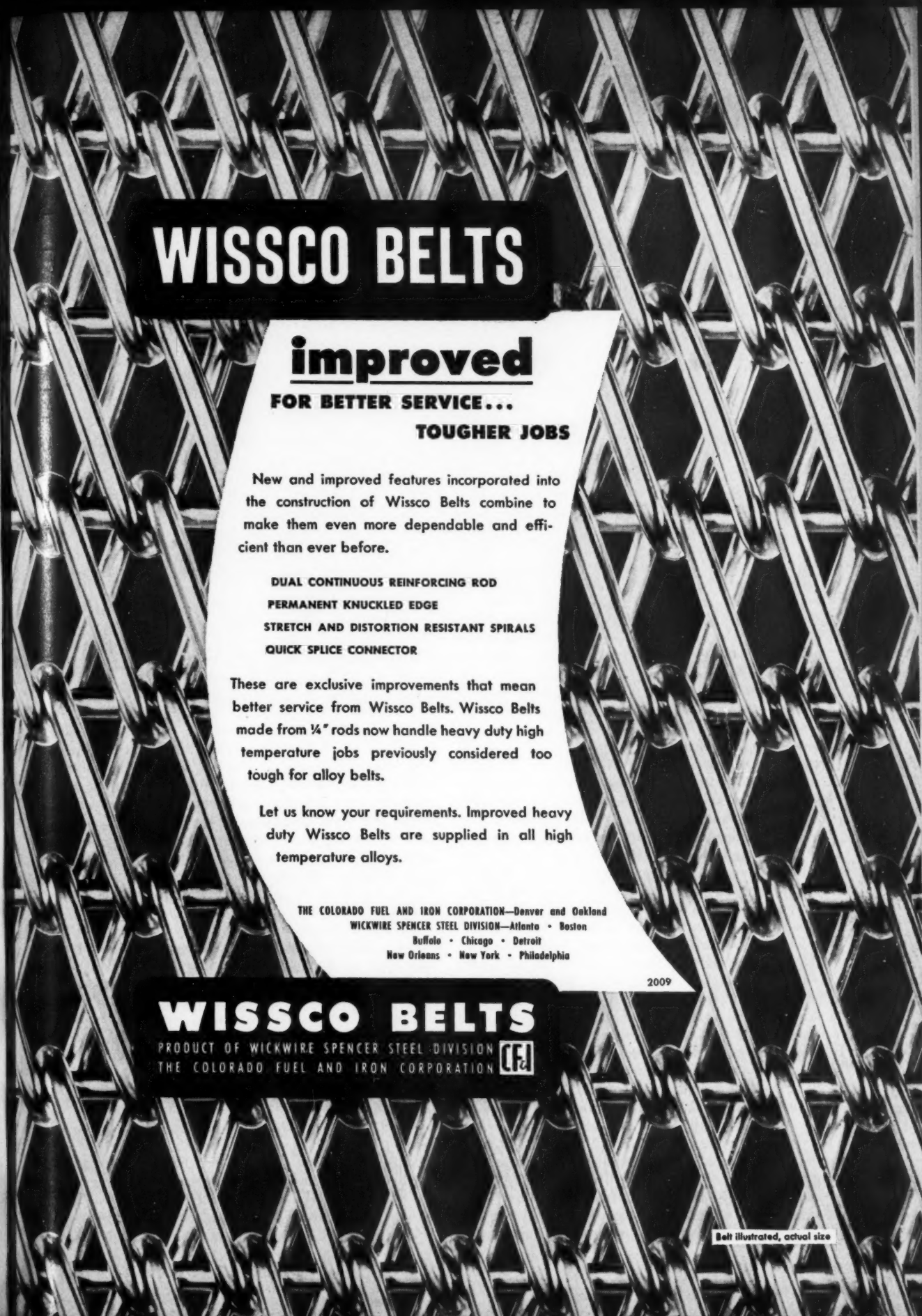


Fig. 8.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CFI
Belt illustrated, actual size

Replica Technique for Measurement of The Surface Durability of Glass

Previous papers by H. E. Simpson have discussed the measurement of the surface durability of flat glass, such as plate and window glass and ground and polished optical reticules, using tests which involved subjecting samples of glass to alternate cycles of surface fogging and clearing.

In these tests, water vapor in the form of a mild surface fog alternately condensed and evaporated on the surface of the sample owing to a deliberate and automatic change in the temperature of the test chamber during a 2-hour time cycle. The temperature was varied only a few degrees above or below the saturation point at 55°C. The deterioration of the glass surface, brought about by this artificial weathering, was evaluated in terms of per cent haze. The total transmission and the amount of scattered light of the weathered sample were measured with a photoelectric haze meter, the relative amount of scattering being considered as a measure of the amount of haze or surface deterioration.

This technique, however, could not be used with samples that were uneven in thickness or that had curved surfaces, such as bottles, containers, ampuls and certain pressed ware. It was found that the specimen acted as a lens, either concentrating or scattering the light source, depending on its presentation to the light beam. For obvious reasons, this technique was also of little value when applied to opaque or highly colored samples. It was apparent that some form of a flat copy or replica of the curved surface was necessary to interpret the corrosion of such samples with the haze meter. The replica technique finally developed is described in the February 1955 issue of the *Journal of the American Ceramic Society*.

A liquid plastic was considered for making replicas and a vinyl plastic dissolved in a suitable solvent was suggested. A mixture of 20% Vinylite resin VYHH (Bakelite Company) and 80% methyl isobutyl ketone by weight was tried and found to offer a number of advantages. The corroded samples were first washed in distilled water and then dried by blowing the excess water from the surface with a jet of filtered air. They were then dipped in the Vinylite plastic solution. In preparing this solution, some difficulty in promoting complete solubility was encountered. Better results were obtained by wetting the Vinylite VYHH with acetone before mixing it with the ketone. After careful dipping, the samples were placed on racks, allowed to dry for 24 hours and dipped once again. While drying, the samples were covered with battery jars to prevent too rapid drying which would have wrinkled the surface of the replica. The drying was carried out at approximately room temperature (75°F.). It was very important to avoid too rapid volatilization of the solvent from the surface of the coating. After complete drying, the plastic coating was stripped from the sample with a razor blade and mounted. These cards were then labeled and stacked in preparation for haze meter evaluation.

TABLE I

	Glass No.							
	1	2	3	4	5	6	7	8
SiO_2	71.7	72.65	71.20	71.20	71.00	71.63	72.97	64.20
R_2O_3	1.8	2.03	1.40	1.30	1.40	1.78	3.16	9.30
CaO	12.2	9.74	10.80	10.50	8.10	6.31	6.45	8.90
MgO	0.11	0.02	2.80	2.80	5.60	4.25	0.07	0.15
BaO	0.62	0.73	0.66	0.64	0.62	0.98	0.53	—
Na_2O	13.4	14.37	12.85	13.40	12.90	15.00	16.11	15.40
K_2O	0.14	0.20	0.33	0.15	0.35	0.07	0.47	2.00
F_2	—	0.26	—	—	—	—	—	—
B_2O_3	—	—	—	—	—	—	0.23	—

In commercial application, it is desirable to know what effects the shape of the container and the size of the constricted opening may have on weathering. However, in the tests described by the author, all surfaces were treated alike and exposed in the same manner. It was found that the testing surface must be chemically clean or free from grease, dirt, fingerprints or any other extraneous coatings before testing. Otherwise, the results of the test can be quite misleading.

These tests make apparent the beneficial effects of alumina, for all glasses containing more than 3% alumina are definitely superior in their resistance to attack by moisture. Magnesia also appears to contribute to durability, but the improvement is less than that shown by alumina.

A number of advantages are evident in the replica test. Replica cards provide a convenient, concise and easily stored record of durability. The method also appears to offer a unique means of studying surfaces of variable thickness and contour. The durability of the surfaces of colored glass, opal glass, alabaster, glazes and vitrified bodies is a possible subject for study. This method also can be employed to study the use of paper interleaves and other types of separators for the protection of glass surfaces, either in storage or in shipment. It also offers a means of studying the effects of stacking glass whose surfaces are in intimate contact during storage.

Samples of flat glass, which had been subjected to the high-humidity test and on which haze-meter readings were taken directly, were coated with plastic and replicas were made of each side. They were treated in exactly the same manner as the curved surfaces of the bottle glass which was tested. The haze determinations for the two replicas were then compared with the values obtained by direct measurement. The haze readings for the replicas were shown to be generally parallel to those of the original surface.

A number of tests were made on various glass containers of the compositions shown in Table I. In each instance the tests were made on both the inside and the outside of the bottle. One significant fact seemed to be apparent in the study of containers: a definitely irregular pattern developed on the surface of the glasses as they were corroded. These surface irregularities also seemed

(*Continued on page* 234)

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Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during January 1955 was as follows: *Flat Glass:* A difference of only .3 per cent is shown in the January preliminary employment figure of 29,000 over the previous month's adjusted 28,900. *Glass and Glassware, Pressed and Blown:* The preliminary figure of 74,000 indicates a drop of .9 per cent from December's adjusted 74,700. *Glass Products Made of Purchased Glass:* January's preliminary 14,500 is .3 per cent under December's adjusted figure of 14,600.

Payrolls during January 1955 were as follows: *Flat Glass:* The preliminary $13,693,897 reported for January is only .2 per cent above the adjusted $13,655,443 reported for December. *Glass and Glassware, Pressed and Blown:* A drop of 1.6 per cent is shown in the preliminary figure of $23,254,747 when compared with the previous month's adjusted $23,655,996. *Glass Products Made of Purchased Glass:* The preliminary $3,903,207 reported for January indicates a drop of 4 per cent from the December adjusted figure of $4,068,047.

GLASS CONTAINER SHIPMENTS
(All Figures in Gross)

Narrow Neck Containers

	February 1955
Foods	846,000
Medicinal & Health Supplies	1,286,000
Chemicals, Household & Industrial	722,000
Beverages, Returnable	397,000
Beverages, Non-returnable	58,000
Beer, Returnable	79,000
Beer, Non-returnable	457,000
Liquors	635,000
Wines	341,000
Toiletries & Cosmetics	696,000
Sub-total (Narrow)	5,517,000

Wide Mouth Containers

Foods	*2,564,000
Dairy Products	178,000
Medicinal & Health Supplies	399,000
Chemicals, Household & Industrial	181,000
Toiletries & Cosmetics	183,000
Packers' Tumblers	155,000
Sub-total (Wide)	3,660,000
Total Domestic	9,177,000
Export Shipments	221,000
TOTAL SHIPMENTS	9,398,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY
(All Figures in Gross)

		Production February 1955	Stocks February 1955
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	6,118,000	9,024,000
	Wide Mouth	*4,093,000	*5,034,000
Dairy Products		206,000	356,000
Beverages, Returnable		576,000	1,493,000
Beverages, Non-returnable		67,000	180,000
Beer, Returnable		186,000	427,000
Beer, Non-returnable		581,000	836,000
Liquors		535,000	914,000
Wines		344,000	446,000
Packers' Tumblers		180,000	182,000
TOTAL		10,211,000	14,058,000

* This figure includes Fruit Jars and Jelly Glasses.

Glass container production, based on figures released by the Bureau of Census, dropped off to 10,211,000 gross during February 1955. This is a drop of 1.1 per cent from January's 10,333,000 gross. During February 1954, production was 9,557,000 gross, or 6.8 per cent under February this year. During the first two months of 1955 glass container manufacturers have produced a total of 20,544,000 gross, which is 4.9 per cent ahead of the 19,566,000 gross produced during the same period last year.

Shipments of glass containers during February 1955 were 9,398,000 gross, or 2.5 per cent off from January's 9,645,000 gross. Shipments during February 1954 were 8,424,000 gross, or 11.5 per cent under February this year. Shipments during January and February 1955 total 19,043,000 gross. This is 9.3 per cent ahead of the 17,420,000 gross shipped at the end of the same 1954 period.

Stocks on hand at the end of February 1955 were 14,058,000 gross, which is 5.9 per cent higher than the 13,264,000 gross on hand at the end of January 1955 and 11.9 per cent higher than the 12,563,000 gross on hand at the end of February 1954.

Automatic tumbler production during January 1955 was 5,492,341 dozens. This is a rise of 2.2 per cent over the previous month's 4,567,675 dozens. During January 1954, production was 5,180,462 dozens. Shipments during January 1955 jumped 15.5 per cent to reach 4,896,855 dozens. This is an increase over the December 1954 shipments of 4,236,729. Shipments during January 1954 were 4,399,343 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during January 1955 were 2,751,588 dozens. This is a drop of 3.5 per cent from the previous month's 2,853,410 dozens. During January 1954, sales had been reported at 2,750,140 dozens. At the end of the 12-month period ending January 1955, sales had totaled 37,921,337 dozens. This is 2.4 per cent under the 38,863,862 dozens sold during the corresponding period in 1954.

• Awards for service ranging from 10 to 35 years were presented to 25 employees of Pemco Corporation at the Seventeenth Annual Dinner of the Pemco Honor Service Society held recently in Baltimore. Added together, the years of service represented a total of 490 years with the company. Over 60 employees now belong to the Pemco Honor Service Society.

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New Equipment and Supplies

THERMAL INSULATION PROTECTIVE COATING

West Chester Chemical Company, Box 39, West Chester, Pa., has announced the development of a new protective coating for thermal insulation, "Lagz," which is compounded from Neoprene, silicone rubbers and other resins to provide a coating that is unaffected by moisture, oils, brine, solvents, corrosive gases, chemicals and weathering.

Lagz has high mechanical strength, provides a moisture resistant cover which protects insulation from damage by abrasion or puncture, and insures high thermal efficiency and low maintenance costs. It is manufactured in two grades. No. 1 is a medium viscosity material designed for use with 85% magnesia, calcium silicate, felt, rock wool and asbestos. It can be applied by spraying, brushing or sponge. Lagz No. 2 is a high viscosity material designed for use with low temperature insulation, such as glass fiber, cellular glass, cork and foamed plastics. It is applied by brush or trowel and is a vapor barrier.

Lagz is non-flammable and non-toxic, is an excellent adhesive. It can be used to fasten insulation to surfaces and to cement the edges of formed insulation bands, with resultant savings in both together without the use of wire ties or bands, with resultant savings in both labor and material.

CATALOGS RECEIVED

Richard C. Remmey Son Company, Hedley Street and Delaware River, Philadelphia 37, Pa., has issued a 12-page booklet, Bulletin CR-11, devoted to a new Remmey product, Crystalite.

The very attractive and informative bulletin points up the advantages of the new product and illustrates various grog sizes. It presents at length a discussion of uniformity, quality, evaluation of spalling, brands and mixes, processing methods, uses and performance results. Quick-reference tables are presented giving properties of Crystalite, Crystalite A and Crystalite Grog; typical chemical analysis; thermal conductivity.

E. F. Houghton & Company, 303 W. Lehigh Avenue, Philadelphia 33, Pa., has made available a handy wall chart containing lubrication recommendations for many industrial needs.

This chart covers such applications as hydraulic systems, spindles, air compressors, reduction gears, electric motors, oven conveyors and other general uses, and is printed on tough varnished stock for protection from smudging or handling.

Minneapolis-Honeywell Regulator Company, Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa., has issued a number of bulletins, some of which are as follows.

Bulletin 7404 describes the Honeywell indicating furnace pressure controller and its uses in measuring and controlling furnace operation.

Bulletin 1060 describes the latest addition to the line of Brown millivoltmeters. The new instrument is housed in a 19-inch wide horizontal case that is suitable for mounting in standard relay racks. It also introduces a new three-zone control form that is adjustable from 0 to 100 per cent or from 0 to 10 per cent of full scale, as desired. The bulletin gives complete specifications, descriptive list of control forms, drilling dimensions and ordering information.

Bulletin 5002 is a new issue of the composite catalog which briefly and concisely describes Honeywell industrial instruments and equipment, including the latest developments.

Bulletin 1120, a new handbook-type, describes pneumatic control and transmission systems. It describes pneumatic controllers, their applications and how they work. Practical information is supplied for the plant operators on how to tune pneumatic controllers to a process, how to introduce manual adjustments and how to provide the best air supply.

The Bristol Company, Waterbury 20, Conn., has published a new edition of their 56-page Bulletin P1238 on thermocouples and pyrometer accessories.

The bulletin contains extensive engineering data on the selection and installation of the proper types of thermocouples, wells, head assemblies and other pyrometer accessories, as well as recommended thermocouples for specific installations.

The Bristol Company has also released a new edition of the price list and specification catalog for Furnace and Oven Control Instruments and Accessories.

Pittsburgh Corning Corporation, One Gateway Center, Pittsburgh 22, Pa., has prepared a new 8-page catalog, "How to Modernize Old Windows with PC Glass Blocks."

The booklet demonstrates with photographs and drawings the specific benefits of a window modernization program to the building owner in terms of lower maintenance and operating costs, better daylight and a more modern and efficient plant. It illustrates how to select the proper functional glass block for use in various window exposures and where the plant location presents such problems as extreme brightness and glare.

American Potash & Chemical Corporation, 3030 West Sixth Street, Los Angeles 54, California, has published a booklet tracing the company's history.

The well illustrated brochure opens with the company's beginnings in 1862, illustrates and discusses its progress and expansion. The company's products and their development, research programs, how products are recovered, marketing, employee relations are all discussed in the booklet. An extensive plant flow diagram is shown.

Bausch & Lomb Optical Company, 635 St. Paul Street, Rochester, New York, has prepared a photographic lens data book which lists pertinent dimensions of 43 lenses readily adaptable to normal applications.

The book is offered as a service to technicians who specify, recommend, select and purchase all types of photographic lenses.

Hardinge Company, Inc., 240 Arch Street, York, Pa., has just issued a revised 4-page bulletin, No. 30-C, covering its line of circular sand filter clarifiers. The mechanism consists essentially of a spiral rotating scraper suspended at the tank center, which takes a cut from the surface of the sand bed when the filter rate decreases.

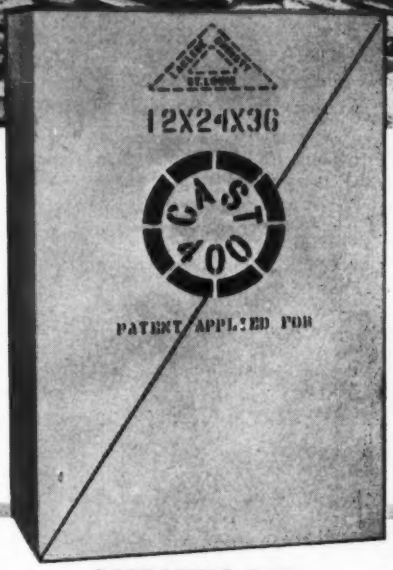
It is used in processes where a crystal-clear filtrate is desired. The bulletin describes operating principles and shows typical performance data and capacities.

Libbey-Owens-Ford Glass Company, Houston, Texas, has published a simplified, concise outline of product standards for translucent fiber glass-reinforced panels.

The company states that the new folder, "What to Look for in a Good Translucent Building Panel," will be helpful to architects, engineers and consumers in giving them a background for quick interpretation of the many standards which apply to weight-thickness ratio, glass content, strength, light transmission, uniformity, surface finish, pitch and depth of corrugations, pits and bubbles, and weather resistance.

American Wheelabrator & Equipment Corporation, 1026 S. Byrkit Street, Mishawaka, Indiana, has published a new bulletin, No. 854, devoted to the various applications of abrasive blast cleaning to problems encountered in industry.

THATCHER SETS RECORD WITH LACLEDE-CHRISTY CAST 400



Cast 400 Bottom Blocks deliver 199 tons pull per sq. ft. of melter

This 1,084-day service of Thatcher Glass Manufacturing Company, Inc. demonstrates Thatcher's outstanding design and operation—and again proves the extraordinary merits of Laclede-Christy CAST 400 Bottom Blocks. The campaign produced 199 tons of glass per square foot of melting end for the life of the furnace. At campaign's end, 12-inch CAST 400, in the melter bottom, was 8 inches thick at the thinnest place.

Evidence from *many* completed furnace campaigns, using the best known engineering practices and various refractories, shows that *you can always expect a maximum campaign from CAST 400.*

CAST 400 Bottom Blocks also afford economy of construction. They are laid up quickly and easily.

If you are not getting these advantages, don't you think you should?

OPERATING DATA

Area of melting end	684 sq. ft.
Depth of melting end	42 in.
Type of glass melted	Soda Lime Flint
Total days	1,084
Operating days	1,071
Total glass produced	136,130 tons
Tons glass per sq. ft. melting end	199 tons
Average pull per day	127 tons
Average rate of pull per sq. ft. melting end, per ton	5.3 sq. ft.

LACLEDE-CHRISTY COMPANY

DIVISION OF H. K. PORTER COMPANY, INC.
2000 Hampton Avenue • St. Louis 10, Missouri
Mission 7-2400

HKP — LACLEDE-CHRISTY COMPANY — Quality First

G. P. MacNichol

R. H. Barnard

NEW L-O-F GLASS FIBERS COMPANY ELECTS BOARD AND OFFICERS

The new L-O-F Glass Fibers Company, recently formed by the merger of Glass Fibers, Inc. into the former Libbey-Owens-Ford subsidiary, has officially begun operations. The first public announcement from the new concern listed its Board of Directors which has been appointed to serve until the first annual meeting of stockholders.

New Board chairman is George P. MacNichol, Jr., who is also President of Libbey-Owens-Ford Glass Company. With L-O-F since 1920, Mr. MacNichol rose through sales ranks of the company and has served as Vice President in charge of Sales, Executive Vice President and was elected President in April 1953. Other members of the Board are Randolph H. Barnard, who is President and General Manager of the new Glass Fibers Company; John D. Biggers, who is Chairman of the Board of Libbey-Owens-Ford; F. E. Cazayoux, who is Comptroller and Treasurer of L-O-F and has been with that company since 1927; Thomas A. Collins, formerly with Owens-Illinois Glass Company; Curtis W. Davis, who has been with L-O-F since 1923 and a Director since 1952; J. M. Johns, who has been with L-O-F since 1922; D. Dean McCormick, formerly a Director of Glass Fibers, Inc.; and Gordon W. Reed, a Director of Glass Fibers, Inc. since 1946 and Chairman of its Board since 1948.

Officers of the newly-formed company have been announced by Randolph H. Barnard, President and General Manager. They are Thomas A. Collins, who has been elected Vice President and Assistant General Manager. Mr. Collins has served with Owens-Illinois Glass Company for 26 years and just prior to joining Glass Fibers, Inc. in 1952, had been General Manager of the O-I Kaylo Division.

Francis H. May, Jr., is Vice President, Secretary and Treasurer of the new company. He has been with Glass Fibers, Inc. since its incorporation in 1944 and was Vice President, Secretary and Treasurer until the recent merger. Previously, he had been with Owens-Illinois. J. M. Johns is Vice President and Director of Sales. He had been with Libbey-Owens-Ford Glass Compay for 33 years.

F. H. May, Jr.

Joseph S. Finger is Vice President and General Manager of the Corrulux Division. Prior to the merger, he had been President of Corrulux, at that time a division of Libbey-Owens-Ford Glass Company. Raymond W. Capaul has been elected Vice President and Sales Manager of the General Products Division. He was previously Vice President and General Sales Manager of Glass Fibers, Inc. Clinton F. Hegg has been elected Vice President and Sales Manager of the Textile Division. He was formerly General Sales Manager of the Fiber Glass Division of L-O-F. He joined L-O-F in 1939. Dominick Labino, who joined Glass Fibers, Inc. in 1947, has been elected Vice President in charge of Glass Research and New Product Development, a similar position to the one he held with Glass Fibers. John A. Morgan is Vice President and General Manager of the Western Division, a similar post to the one he formerly held with Glass Fibers, Inc. Jesse H. Plummer has been elected Vice President in charge of Manufacturing, Engineering and Development. He had formerly been Vice President and General Factories Manager of Glass Fibers, Inc., prior to which he had been associated with Owens-Illinois.

G.C.M.I. SPRING MEETING

The Board of Trustees of the Glass Container Manufacturers Institute has announced that the 1955 Spring Meeting of the Institute will be held at The Greenbrier, White Sulphur Springs, West Virginia, May 9, 10 and 11.

The purpose of the meetings will be to provide an opportunity for the Board of Trustees to receive semi-annual reports from the nine standing committees and to make the same available to the membership, and to hold the Annual Membership Meeting for, among other things, the election of three Trustees to serve a three-year term.

The Program Committee appointed consists of J. Stanley Heuisler, Chairman, and G. F. Collins and K. C. Frazier. A detailed program of the activities will be announced later.

MORGANTOWN GLASSWARE FILES SUIT

The Morgantown Glassware Guild, Inc. has filed a suit in the United States District Court for the District of Columbia which will test the constitutionality of the Trade Agreements Act and of United States participation in General Agreement on Tariffs and Trade. In a complaint naming Secretary of the Treasury George A. Humphrey as defendent, the glass company cites injuries to its business resulting from alleged unconstitutional tariff reductions.

A manufacturer of handblown glassware, the Morgantown company claims that Congress does not have authority to delegate its tariff powers to the President. The complaint further states that tariff reductions, made under the Trade Agreements Act and for GATT, are solely responsible for a drop in annual business of $1,250,000 in 1949 to $750,000 in 1954.

DOMINION GLASS ELECTS NEW DIRECTOR

I. R. Macdonald has been elected to the Board of Directors of Dominion Glass Company Limited.

Mr. Macdonald is presently General Sales Manager of the company, which position he has held since 1938. He has been employed by the company for 37 years.

Spur Speeds Nephsy to You . . .

Vast Blue Mountain Nepheline Syenite Deposits Now Nearer To You Because of New $1,500,000 Rail Spur

Bulk shipments of "Lakefield" Nepheline Syenite from Blue Mountain, Ontario to the ceramic industry throughout the nation will be speeded by the new 17-mile rail line recently completed by the Canadian Pacific Railroad.

Its high alumina and alkali values and its extremely low iron content make "Laflefield" Nepheline Syenite the best and most economical means of introducing aluminum oxide into the batch. And, you can rely on its uniformity year after year . . . batch after batch.

Write or wire today for complete information.

CHEMICAL ANALYSIS

Lakefield Nepheline Syenite

SiO_2	60.8%
Al_2O_3	23.3%
Fe_2O_3	.07%
CaO	.6%
MgO	.1%
Na_2O	10.0%
K_2O	4.5%
Ignition Loss	.6%
	99.97%

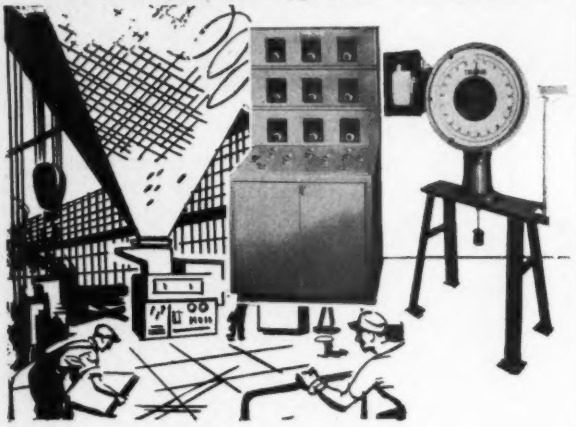
Great Lakes Foundry Sand Co.

United Artists Building

DETROIT 26, MICHIGAN

NEW Automatic Batching System

For Rapid, Accurate Weighing with THURMA-Tronic SCALES



APPLICATION

The Thurma-Tronic batching system is adaptable for use in any batching operation of the glass industry. This new electronic batching system is not only available for new plants but it is also adaptable to most existing plants. If you wish to increase production and reduce batching costs, it will pay to investigate the money-saving advantages of the automatic and accurate Thurma-tronic batching system.

SPECIAL FEATURES

FOR ALL BATCHING PLANTS . . . OLD or NEW—The Thurma-tronic batching system may be used on any existing plant as well as on original installations.

UNLIMITED INGREDIENTS and FORMULAS—Because of the electronic design, any number of materials may be controlled. In addition, any number of preset formulas may be weighed by the Thurma-tronic batching system. Changes in formulas are quickly made by resetting the dials.

RAPID WEIGHING—The Thurma-tronic batching cycle is accomplished in a matter of seconds. This system may be set by the operator for one batch, continuous batching or any specific number of batches.

VERSATILE—The Thurma-tronic batching system is adaptable to either accumulative or simultaneous weighing batch plants.

SERVICE—Because this is an electronic unit, based on the same principle as radio, any competent radio repairman can check tubes and make repairs in the event servicing becomes necessary.

ACCESSORIES—Strip chart recorders, one turn dials and other modifications are available for specific requirements of any batching operation.

Complete information on Thurma-tronic batching systems is available by writing for Bulletin 701. If, however, you have a specific batching problem, give us general information and our engineers will be glad to work out the details with you.

THURMAN MACHINE COMPANY

Precision Products Since 1918

154 NORTH FIFTH STREET, COLUMBUS, OHIO

SHOCK-ABSORBENT PACKAGE FOR CATHODE RAY TUBE

Fragile cathode ray tubes are now being shipped by Tektronix, Inc. in shock-absorbent corrugated boxes made by Gaylord Container Corporation.

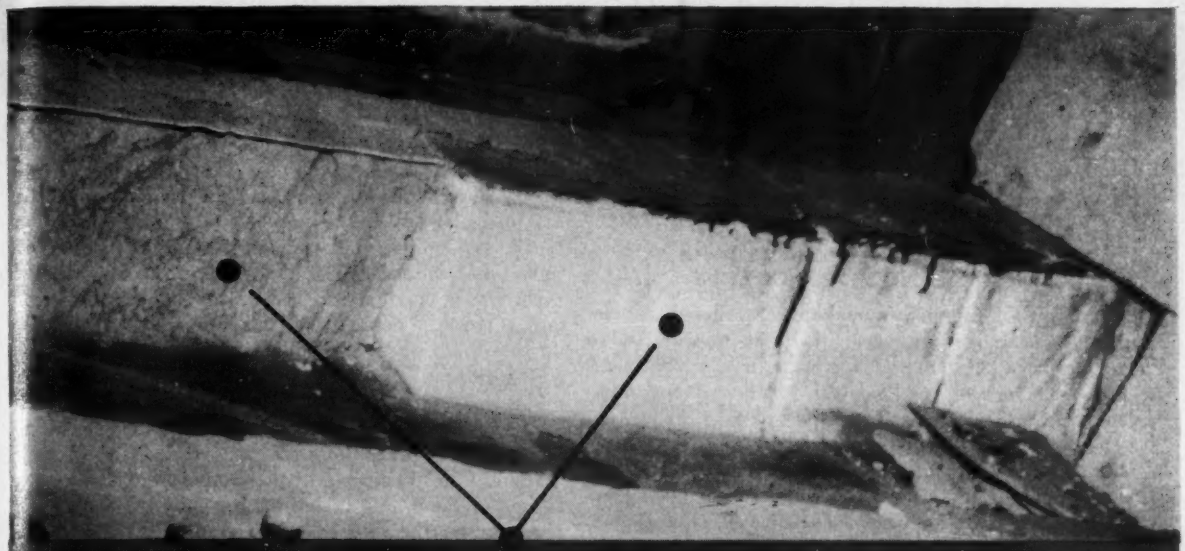
The corrugated container, which protects the delicate tube in transit, is made of resilient double-wall fibreboard. A special inner corrugated jacket is firmly centered by flanges which extend from both ends and middle for three-point support. Additional top and bottom pads of corrugated board and cotton cellulose effectively cushion the 2½-pound electronic instrument. Ease of assembly and packing is another feature of this package. With the sleeve positioned in the container, the tube is inserted and pads placed at each end. Tape is then applied to top and bottom flaps and the unit is ready for shipment.

A.C.S. PITTSBURGH MEETING

"Now and Tomorrow" was the title of Charles P. Lohman's talk at the April Pittsburgh Section meeting of the American Ceramic Society. Mr. Lohman, Sales Manager for Pemco Corporation, described a number of new and promising uses of ceramics, particularly in the architectural field.

Concurrent with Mr. Lohman's talk, a "glass group" meeting was held. The purpose of the meeting was to determine whether or not there is enough interest from glassmen in the Pittsburgh Section to form a glass group. Ideas as to how such meetings might be conducted and what types of programs might be offered were considered. Neill Brandt, of Mellon Institute, acted as chairman of the "glass group" meeting.

FOR YOUR FEEDER CHANNELS



WHICH BLOCKS WOULD YOU PICK?

The ones next to the tank outlet, we'll wager. For these were chosen by the operator himself . . . to line 18 more complete feeder channels right up to the bowl!

Both materials were in use three years against flint bottle glass. Blocks in the more-favored position to the left are pitted and grooved badly. Considerable joint erosion also is evident. Their spongy appearance might indicate a source of stones or cords in the glass.

The right-hand MONOFRAX® M fused cast blocks present quite a contrast. Despite location in the hottest, most corrosive part of the channel, they are smooth and clean. There is no grooving or pitting.

Feeder channels fully lined with MONOFRAX M blocks should help keep glass quality high. And because of his selection this operator expects at least two full campaigns.

MONOFRAX M *materials are the most nearly pure of all commercial glass tank refractories. They consist of over 98% alumina, with less than 0.07% impurities, and next-to-no interstitial glass. Their dense, tightly-locked crystalline structure is especially resistant to erosion by molten glass, and their high degree of purity protects the color and quality of the finished product.*

CARBORUNDUM

Registered Trade Mark
The Carborundum Company
Dept L35, Refractories Div.
Perth Amboy, N. J.

the trend is to **MONOFRAX® FUSED CAST** *refractories*

ARMSTRONG'S NEW BUILDING FEATURES NEW TRADEMARK

Armstrong Cork Company's modernized trademark made its first appearance on a structure when this new consolidated office building and warehouse in Cleveland was completed. The new building is at Superior Avenue and 30th Street and is leased to the firm.

The building has 11,000 square feet of floor space and houses district offices of the Glass and Closure, Building Products, Floor, Industrial and Insulation Divisions. Warehouse space is for insulation materials only.

The building is air conditioned and has Armstrong resilient floors and acoustical ceilings throughout.

DIAMOND ALKALI TEAM AIDS HOLLAND'S SODA ASH PROJECT

A four-man "design-aid team" from Diamond Alkali Company's technical group is now in Holland working with Dutch engineers to complete equipment and process design for the construction of a new, 51-million guilder soda ash plant scheduled to go "on stream" in the summer of 1957. The Diamond Alkali team will remain in Holland for approximately one year on this phase of the project.

The new plant, Holland's first soda ash plant, is part of a progressive, country-wide postwar program of industrialization sparked by the Netherlands Government to meet the demands of a predominately agricultural economy. The plant will have a daily productive capacity of 480 tons of soda ash.

Financed jointly by private, semi-private and state funds, the 51-million guilder facility is based on an enormous salt deposit, estimated at 20-billion tons, discovered shortly after World War II near Winschoten in the northern part of the Dutch province of Groningen. The plant will be located at Delfzijl on the Eems estuary near the Netherlands north coast.

During the past three months, six Dutch engineers have been located at Diamond's Research Center in Painesville, Ohio, where they have been working in cooperation with Diamond engineers exploring various phases of the project, including determination of process data, establishment of heat and material balances and selection of principal equipment units for the new plant. Later on, after construction gets well under way, Dutch operators will be sent to Painesville for equipment operation and maintenance training.

• The Second Annual Conference for Engineers and Architects is to be held at The Ohio State University on May 6, 1955. The Department of the College of Engineering will hold technical sessions and open houses during the afternoon and evening.

GLASS CONTAINER WORKERS OBTAIN WAGE INCREASE

Four days of negotiation between the Glass Bottle Blowers Association, AFL, and the Glass Container Manufacturers Institute has resulted in a 5¢ per hour wage increase for union members in glass container plants. The annual wage reopening conference was attended by 50 delegates of the union and the same number of employer representatives for 37 companies which operate 100 plants throughout the country.

The negotiations increased basic hourly rates for 8,000 operators to $1.87 and upkeep men to $1.97. Negotiations for other employees in the glass container plants will follow, but the schedule set in the current negotiations usually sets a pattern for the industry.

A guaranteed annual wage in the industry was brought up for discussion by Lee W. Minton, International President of the Union, who headed the union negotiating committee. Due to the fact that current talks involved a wage reopening only under terms of the contract signed in 1954, the matter was deferred.

Ralph Lind, Chairman of the Committee on Labor Relations of the G.C.M.I., headed the industry representatives. Among the glass container firms represented at the conference were Owens-Illinois Glass Company, Anchor Hocking Glass Corporation, Hazel-Atlas Glass Company, Brockway Glass Company, Thatcher Glass Manufacturing Company, Knox Glass Associates, Ball Brothers Company and 30 other firms.

OWENS-ILLINOIS TO CONSTRUCT CUBAN PLANT

Owens-Illinois Glass Company has acquired a 148-acre site 20 miles southeast of Havana for the purpose of constructing a plant to supply glassware for the Cuban market. The announcement was made following a meeting of President Batista and other government and industry representatives with officials of the glass company.

J. P. Levis, Chairman of the Board of Owens-Illinois, said that construction will start after the company concludes engineering and financing details and successfully completes negotiations on labor and taxation. He further stated that tentative plans call for the plant to be a two-furnace operation patterned after the company's newest U. S. factories and will be equipped with the most modern manufacturing facilities. With the exception of a few Owens-Illinois technicians and supervisors, all employees will be Cubans. Raw materials, principally sand and limestone, will come from Cuban suppliers, and the plant is to be operated by a newly-formed Cuban company. The proposed plant represents the company's first venture into manufacturing outside of the United States.

A.G.A. ELECTS CHAIRMAN OF BOARD OF GOVERNORS

W. L. Orme, President of the Cambridge Glass Company until his retirement from the glass business, has resigned as Chairman of the Board of Governors of the American Glassware Association. The Governing Board has unanimously elected J. Nelson McNash to succeed him in that office.

Mr. McNash is Vice President of Hazel-Atlas Glass Company and for a number of years has served on the Board.

Milk-Pad Test Demonstrates

LOW INSOLUBLE RESIDUE

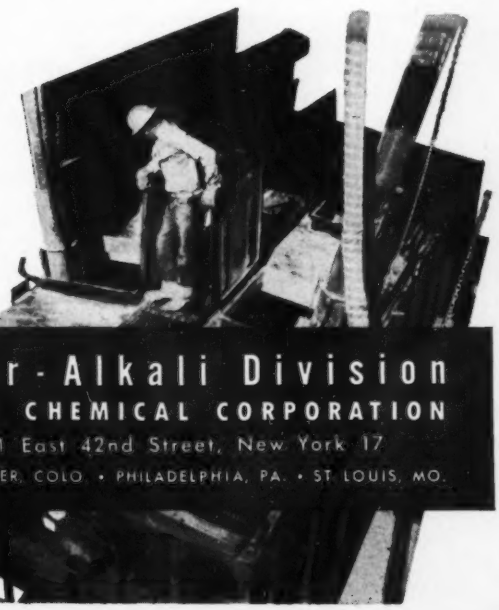
in Westvaco® Soda Ash

The American Public Health Association uses this test to determine the insoluble impurities in milk. But the milk-pad test also graphically shows the low insoluble residue in WESTVACO Soda Ash. There's a very simple "reason why" this is so!

To make WESTVACO Soda Ash, we mine thousands of tons of unbelievably pure trona underlying our Westvaco, Wyoming plant. Then we crush it and dissolve it. Right here insoluble impurities drop out. They never do get to the crystallizer or the calciner from which refined soda ash emerges as the end-product of our patented process.

Low insolubles is only one of its inherent qualities. Others are low iron, low salt and sulfate, low calcium. Equally important are high purity (99.8% Na_2CO_3), high rate of dissolution and exceptional flowability.

Users from the Mississippi Valley to the Panhandle to the Pacific benefit by this nearby source of high quality soda ash. May we send samples and quote?



fmc FOOD MACHINERY AND CHEMICAL CORPORATION — Westvaco CHEMICALS

Westvaco Chlor-Alkali Division
FOOD MACHINERY AND CHEMICAL CORPORATION
General Offices · 161 East 42nd Street, New York 17
CHARLOTTE, N. C. • CHICAGO, ILL. • DENVER, COLO. • PHILADELPHIA, PA. • ST. LOUIS, MO.

Some European Factories . . .

(*Continued from page* 206)

housing allowance of $37.00; in France $37.60; in Holland $36.75 to $82.90. In Norway married men live rent-free in the oldest houses; in remaining houses, rental is $50.40 per annum. In newer houses not belonging to the employer, the rent ranges from $67.20 to $210.00 per annum. In one Swedish factory, no free houses exist but very low rentals are available, ranging from $.047 to $.058 per hour of wage. In another factory, single men share a single furnished room (including laundry) at $30.00 per annum; individual furnished room (and laundry) costs $48.60 a year; a married man gets one room and kitchen for $34.70 (unfurnished), or a semi-modern room and kitchen (with heat and light) at $46.30 per annum. Three semi-modern rooms and kitchen with heat and light cost $127.30, and an all-modern two-room and kitchen with heat and light costs $173.60 per year.

Fuel Allowances. In Denmark $37.00 is given the workman per annum, and in Holland there is an allowance of $15.72 per ton of anthracite. No fuel allowances were reported by manufacturers in other countries.

Taxes. This item is difficult to interpret. In Denmark the reported wage tax is 5.22%; in France over 30%; in Norway 20 to 40% paid by employees; in Sweden 16.23% for single and 15 to 18% for married men.

Unemployment Compensation. In Holland there is an unemployment compensation of 80% of the wage. One Swedish factory pays 0.6 of the "ordinary" wage to single men and 0.8 to a man with a family; another company does not "award" any unemployment compensation.

Pensions. Denmark does not provide pensions. Holland pays two-thirds of the average salary; after 30 years of service, one Swedish factory pays $77.20 per annum to retired single workers and $115.00 to married men.

Medical Service and Disability. France provides 20%. Holland pays hospitalization for a maximum of 42 days and 95% of the salary during illness for one year. Norway has a sick-relief fund which provides for free medical attention in a hospital. This costs the employer $.237 monthly for single and $.675 monthly for married men. In Sweden one employer pays about $.319 per month for each employee ($.237 single and $.675 married) to a sick-fund controlled by the authorities. This provides 2/3 free medical attendance and therapy, ½ of the cost of medication, free hospitalization.

Social Security. A French manufacturer reports paying 5% of wages for social security. In Holland social laws are said to award 32% of the salary. No mention is made of social security in reports from other countries.

Group Life Insurance. One Swedish factory reports a voluntary plan whose cost is paid share-and-share alike by employer and employee.

Food Costs. The price is per kilo (2.2 lbs.) Potatoes, Holland $.044. Bread, France $.16, Holland $.09, Sweden $.19 to $.20. Eggs, Holland $.45 per dozen.

Shoes. Good working shoes cost $12.86 per pair in France, $4.73 in Holland, $7.33 in Sweden.

While the statistics reported do not cover all glass factories in Denmark, France, Holland, Norway and Sweden, and do not even include other European countries, they afford some idea of wages, costs, benefits. The European worker may work for less, but he benefits accordingly. He cannot enjoy the luxuries that our higher American wages, costs and benefits provide.

The writer of this report gratefully acknowledges the friendly cooperation of representatives of European offhand factories who made the presentation possible.

CORNING NAMES MANAGER OF NEWLY-DEVELOPED DEPARTMENT

Edward C. Leibig has been appointed Manager of the newly-formed Market Development Department of the Technical Products Division at Corning Glass Works, it has been announced by Russell Brittingham, Vice President and Division General Manager.

In his new capacity, Mr. Leibig will expedite development of major new products and new markets in the field served regularly by the Technical Products Division. Manager of the Division's Optical Department since 1948, he will continue to direct that group's sales and engineering staffs along with his new responsibility.

Associated with the company since 1929, Mr. Leibig first served as a chemist in the research laboratory. He later became Manager of the company's plant in Wellsboro, Pa., and then managed the Central Falls, R. I., plant. He returned to Corning in 1943 as Assistant Manager of Main Plant, and was advanced a year later to Manufacturing Manager of the Technical Products Division. In 1945, he was named assistant to the Vice President in charge of Manufacturing, and in 1948 became Manager of the Optical Department.

• John M. Maitland has been named Manager of the Detroit District Office of The Bristol Company, according to a recent announcement. He joined the firm in 1944 on the sales staff of the Cleveland office.

L-O-F GLASS FIBERS QUALITY CONTROL MANAGER

H. Matthew Bowers has been appointed Manager of the Quality Control Department at the Parkersburg factory of the L-O-F Glass Fibers Company, it has been announced by J. M. Johns, President.

Mr. Bowers joined Libbey-Owens-Ford Glass Company in 1949 as an analytical chemist in the company's Toledo Technical Division. In 1951, he was transferred to the Parkersburg factory where he worked as an analytical chemist in the Quality Control Department. Prior to joining L-O-F, he had been a chemist at a Westinghouse Electric Corporation.

HOUZE NAMES SALES DIRECTOR

Donald L. Nevins has been appointed Director of Sales of the Houze Glass Corporation, according to an announcement by E. V. Ogg, President.

Mr. Nevins, who was formerly Sales Manager for Dunbar Glass Corporation, will direct a national sales program for all Houze-Art colored glass products, which includes window glass, giftware, glass greeting cards and technical glass.

Prior to joining Dunbar Glass, Mr. Nevins had been associated in executive capacities with Pittsburgh Corning Corporation and Corning Glass Works.

Shipment after shipment . . .
Pure Uniform Glass Sand 99.9% SiO_2

Another carload of the world's finest Silica Sand is loaded for shipment by Pennsylvania Glass Sand Corporation. Unequalled purity and perfect uniformity have made our Glass Sands the recognized standard of quality for all types of glass production.

Seven modern plants, equipped with huge storage facilities and located on major railroads, are your assurance of prompt, dependable shipping service. Write today for complete information, and remember —*the Better the Silica, the Better Your Product!*

Pennsylvania Glass Sand

TWO GATEWAY CENTER, PITTSBURGH, PA.

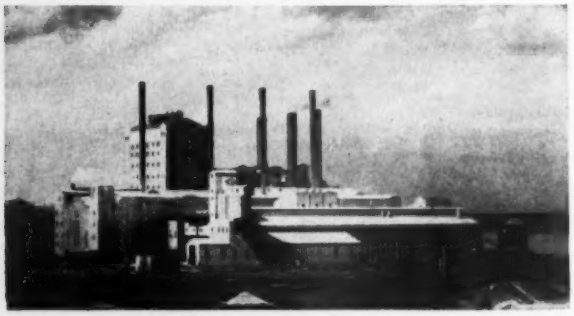
Nation-wide Shipping Service from Seven Plants

BERKELEY SPRINGS, W. VA. · HANCOCK, W. VA. · MAPLETON, PA. · McVEYTOWN, PA. · NEWPORT, N. J. · KLONDIKE, MO. · MILL CREEK, OKLA.

Milestones in Glass Progress

PHOTO COURTESY TOLEDO MUSEUM OF ART

50 During the early part of the Christian era, glassworkers were masters of nearly all manufacturing and decorating techniques of major importance in the industry's development. The Romans used glass primarily in pavements, and in thin plates as coating for walls. Typical are these mosaic and onyx fragments.



1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation, was founded by Captain J. B. Ford to supply Soda Ash to the glass industry; part of Wyandotte's modern Soda Ash facilities is shown above. Wyandotte has literally grown up with glass. Today, as in the past, it is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

Wyandotte
REG. U. S. PAT. OFF.
CHEMICALS

Wyandotte Chemicals Corporation, Wyandotte, Michigan
Offices in Principal Cities

Founded by a Glassmaker to Serve the Glass Industry

Automatic Machines . . .

(*Continued from page* 200)

another drying and additional inspection, a hand-held applicator spreads carbon base, conductive coating inside the funnel between anode button and face-plate as the bulb is mechanically whirled as if on a potter's wheel, tracing a black band to absorb and neutralize the effects of electrons "bouncing" from the screen while the tube is in use.

Except for a negligible proportion of non-aluminized tubes, in the subsequent manufacturing step intense heat vaporizes an aluminum fragment suspended within the bulb, and coats the screen with a thin mirror-like metallic film.

After being blackened and aluminized, the bulbs enter one of the plant's two conveyor-type bake-out ovens. Specially built for the purpose and suspended from roof trusses in the production building, each gas-fired oven extends some 700 feet in length, over twice the goal to-goal distance of a football field. Bulbs enter the ovens at room temperature and progress through carefully controlled increments of heat to a point exceeding 400 degrees centigrade, remain there for a predetermined period and gradually return to room temperature as they approach the ovens' ends and still another rigorous inspection.

Now an electron "gun" is sealed in, and the neck carefully cooled past its annealing point. With this step, the bulb has all but completed its journey toward becoming a tube. Assembled in a delicate series of operations by women employees, the "gun" propels a stream of electronic impulses activating the phosphor screen and creating highlights and shadows according to the image being received when at last the tube goes to work in a TV set.

After yet another inspection, the bulb progresses to an exhaust oven where it is evacuated of air, the occluded gases in the metal parts of the gun are removed and the cathode is activated. In a subsequent hand-operation, the bulb is "tipped off" or flame-sealed. At this point, a Bakelite base is threaded to wires leading from the electronic gun at the neck, and a small oven is attached, which travels the production line with the tube until the base is baked on. Finally, a pair of "getters" are electrically flashed, a process in which the barium compound in the "getters" explodes. The vapor thus created collects residual gases and foreign matter and safely deposits them on the funnel's inside surface (see front cover). Next comes a soldering operation to connect the wires to the pins in the base. A period of stabilizing the electrical characteristics completes the tube's processing.

After manufacture, significant samplings of the tubes are chosen at random to remain in the plant for exhaustive evaluation of their life expectancy. Of the tubes destined for market, each undergoes exacting tests under actual operating conditions before it proceeds to the finishing department to be branded, labeled and packed.

• The 1955 Eastern Conference of the Controllers Institute of America will be held April 28-30, 1955 in the Royal York Hotel, Toronto. C. R. Fay, Vice President and Comptroller of Pittsburgh Plate Glass Company, will preside at a luncheon session. Mr. Fay is national President of the Institute.

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Thermal Emissivity . . .

(*Continued from page* 197)

acteristic infrared absorption as a function of temperature and chemical composition. The effects of certain "coloring" oxides and ions in the structure of the glass are well known for being of great influence on the thermal characteristics of a glass tank. We are fortunate enough to dispose of a valuable recent material, especially published by the Institute of Physics of the University of Frankfurt am Main, which may be discussed in a later communication.

Acknowledgement

I wish to express my gratitude to Dr. Marcel Michaud, Comité Français d'Etudes sur le Rayonnement des Flammes, Paris, for his permission to use his excellent monograph on Thermal Emissivity of Refractories, and his most valuable designs and numerical data.

Further, I thank the McGraw-Hill Book Company, Inc., for their permission to reproduce the text-figure from the book "Pyrometry" of W. P. Wood and J. M. Cork (1927), page 98. W. E.

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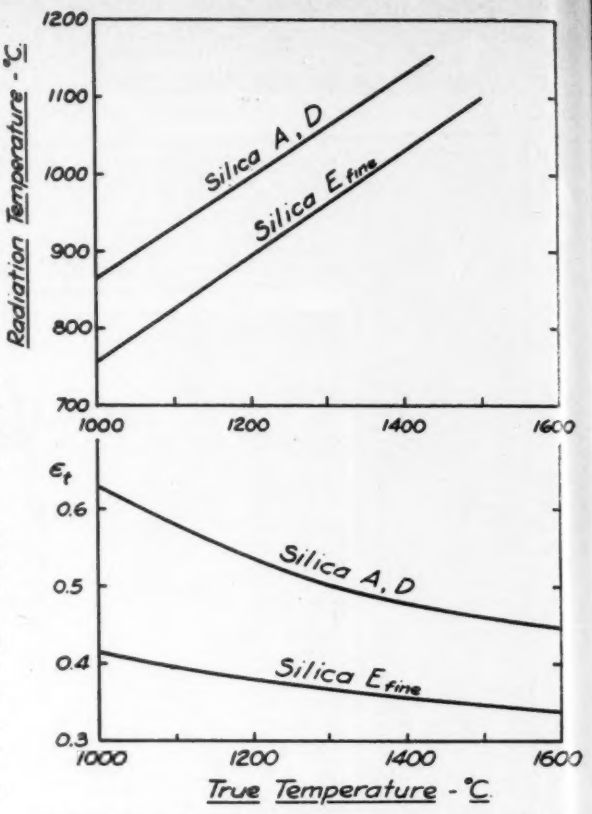

Fig. 9. Temperature function of the emission from silica refractories of different granulometric composition. Radiation temperatures. (Michaud, 1954).

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2 Verhandlg. Deutsch. Phys. Ges. *5*. 1903. 2ff.

3 The principle of such a heating method has been previously used by C. Féry, Ann. d. phys. chim. *27*. 1902. 433.

4 Annal. d. Phys. *18*. 1905. 728; *20*. 1906. 593; Verhandlg. Deutsch. Phys. Ges. *7*. 1905. 346; *8*. 1906. 41, 158.

ANNUAL REPORTS OF GLASS COMPANIES AND SUPPLIERS

Sales for Pittsburgh Plate Glass Company during 1954 were $431,016,283, a decrease of slightly less than 5% from sales of $451,964,697 in 1953. The company's net earnings for the year were $38,637,629, equivalent to $4.18 per share, an increase of 5% compared with net earnings of $36,864,785 in 1953, which was equivalent to $4.07 per share then outstanding.

Lynch Corporation reports sales of $6,203,897 during 1954, compared with $6,364,598 during 1953. Net income during 1954 was $405,241, as compared with 1953's $405,203.

General Refractories Company reported that sales for 1954 amounted to $37,436,338, compared with $51,766,834 for 1953. Net earnings totaled $2,806,706 for 1954, or $2.84 per share, as compared with the 1953 figures of $4,206,270 and $4.26.

Babcock & Wilcox Company's annual report showed sales of $250,471,000, against $305,746,000 during 1953. Net income for 1954 was $15,212,000; for 1953, $12,061,000.

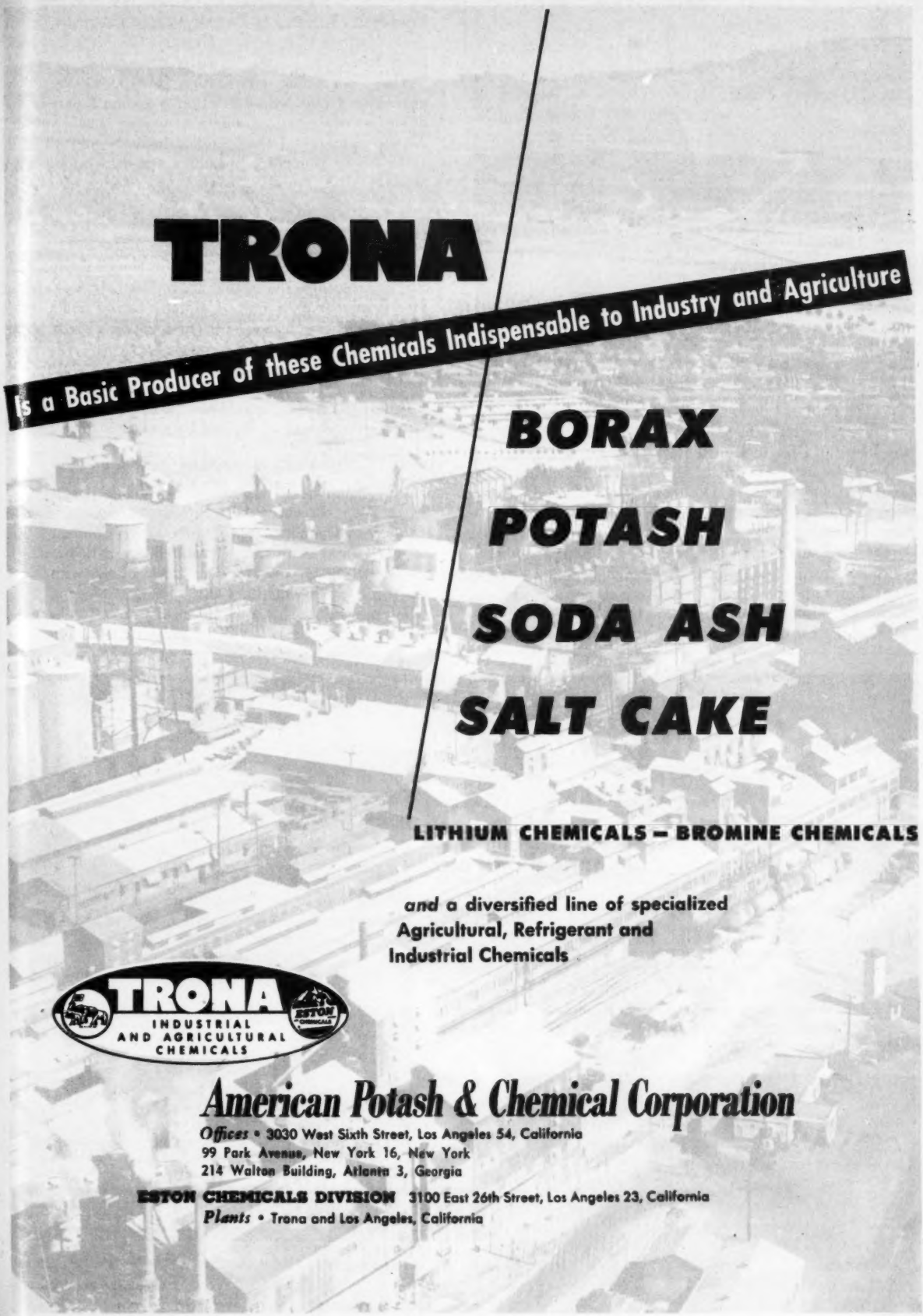
Sales of Diamond Alkali Company totaled $93,505,530 during 1954, setting a new all-time peak. Sales during 1953 were $86,734,279, the previous record high. Earnings in 1954 were $5,528,600, equivalent to $2.21 per common share. This compares with $5,939,189, or $2.39 per common share in 1953.

During 1954, sales of Link-Belt Company were reported to be $111,218,611, compared with $129,792,444 during 1953. Net earnings during 1954 were $5,447,542, as compared with 1953's $7,397,792.

HOMMEL SALES APPOINTMENT

Philip W. Butters has joined the sales and service staff of The O. Hommel Company and will be associated with John E. Crumrine contacting porcelain enamel plants in the eastern territory.

Mr. Butters earned his Ceramic Engineering degree at Rutgers University in 1941, and was immediately called to Army service. For the past seven years, he has been associated with Such Clay Company, Roberts and Manders, and just prior to joining Hommel, he held the position of General Foreman at Kaiser Metal Products.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OFFICERS AND BOARD ELECTED BY TWIN CITIES ASSOCIATION

The Twin Cities Chemical and Allied Trades Association has announced the election of officers and members of the Board of Directors for the year 1955.

Members of the Board of Directors, from left to right above, include: Sidney O. Lancaster, Diamond Alkali Company; Arthur A. Hibbeler, Retiring President, Monsanto Chemical Company; John F. Chaney, Hazel-Atlas Glass Company; James F. Kerns, Columbia-Southern Chemical Corp.; and John D. Schofield, Barrett Division (not shown above). Officers who were elected are Ted A. Wamstad, Mallinckrodt Chemical Company, Treasurer; Clifford P. Barth, Merchants Chemical Company, Vice President; William J. Fenelon, Hilex Company, President; Norman P. Anderson, Hawkins Chemical Company, Secretary.

The Twin Cities organization is enjoying its second year. This group, whose function is a counterpart to that of similar organizations, offers a common meeting ground for the members of the chemical industry and all of its allied trades. Luncheon meetings are held on the third Monday of the month.

ANCHOR HOCKING EXECUTIVE CHANGES

Wm. V. Fisher, President of Anchor Hocking Glass Corporation, has announced that W. B. Snell, Jr. was elected Vice President in charge of Manufacturing and Gordon W. Herrold was elected Vice President in charge of Research and Engineering.

Mr. Snell has been with Anchor Hocking since 1937. He has been General Manager in charge of Manufacturing since 1949. Mr. Herrold has been with the firm since 1927, and in charge of General Engineering since 1950.

THATCHER NAMES MIDWEST SALES MANAGER

W. L. Green, Executive Vice President and General Sales Manager of Thatcher Glass Manufacturing Company, Inc., has announced the appointment of Bernard B. Freitag to head that company's Midwest Sales Office, with headquarters located in the Pure Oil Building, Chicago.

Before joining Thatcher, Mr. Freitag was in charge of Food Container Sales for Ball Brothers Company.

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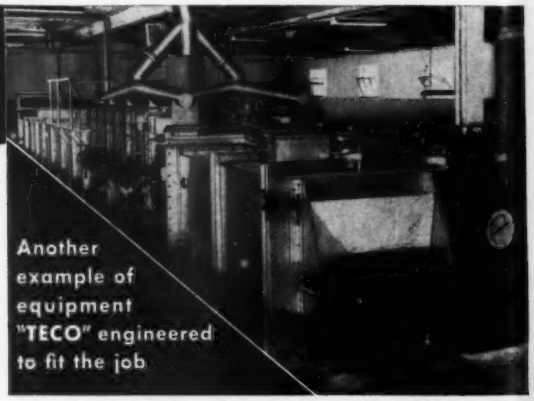

If you have a glass processing operation or series of operations which involve bending, decorating and annealing, we'll be pleased to discuss it with you in terms of what our combination lehr has to offer. If desirable we will design and build a special unit to meet your specific needs.

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PITTSBURGH CORNING DEVELOPS NEW MATERIAL

The development of a cellular glass insulating material which combines both insulation and ceramic finish in a single unit has just been announced by Pittsburgh Corning Corporation.

Called "Duraface Foamglas," the new material provides a durable, impact-resisting surface, along with high insulating and moisture-proof qualities. Years of research at Pittsburgh Corning's laboratories resulted in perfection of a manufacturing process to produce, in a single operation, "Foamglas" having a hard white crust three-fourths of an inch thick on the surface.

Like regular Foamglas, the material is completely inorganic. Thus it will not rot or deteriorate and is not affected by fungus. It does not provide food or nesting material for rats and other vermin, and its rigid structure serves as a barrier to rats. Being made of pure glass, the material is resistant to nearly all chemicals.

The dual-purpose insulation blocks are manufactured by integrally-fusing the dense face with regular Foamglas. This, according to Pittsburgh Corning engineers, eliminates any possibility of the surface finish peeling or cracking off. Impact tests on the dense face of the material show it has about twice the impact resistance of a cement plaster finish.

ARMSTRONG EXPANDS GLASS CONTAINER FACILITIES

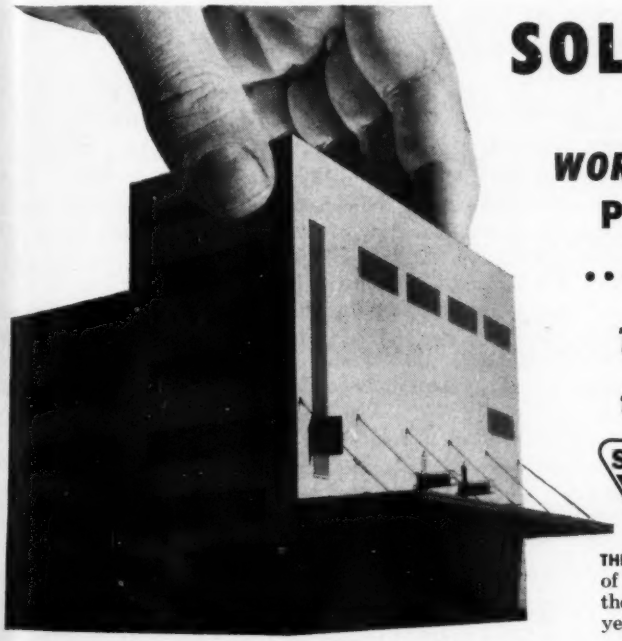
A two-year construction project that will add more than 100,000 square feet of floor space to the Armstrong Cork Company's Millville, New Jersey, glass container plant has been announced by J. C. Feagley, Vice President and General Manager of the Glass and Closure Division.

Mr. Feagley said the Millville construction will add completely modern space and equipment for inspection, carton assembly, packing and shipping operations. Construction of the new building will be started at once and is expected to be completed by late 1956. Regular production and shipping schedules will be maintained during the construction.

PPG EXECUTIVE CHANGES

The appointment of Paul A. Ketchum as assistant to the President of Pittsburgh Plate Glass Company has been announced by H. B. Higgins, President of the firm. Prior to his appointment, Mr. Ketchum had been Manager of Trade Sales since 1952. He has been associated with the glass firm for 24 years, during which time he has served as Manager of several of the company's distributing branches. Mr. Ketchum also was Assistant General Manager of PPG's Merchandising Division for seven years.

Also announced was the appointment of R. F. Barker as General Manager of Planning for Pittsburgh Plate Glass Company's Glass Manufacturing Division. Prior to his appointment, Mr. Barker has been assistant to the President since 1952. Associated with PPG since 1935, he also has served as both Assistant Manager and Manager at several of the company's distributing branches. In 1948, he was transferred to the firm's general headquarters and appointed Assistant Manager of Plate Glass Sales.



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Chloroform • Methyl Chloride

Furnace Instrumentation . . .
(*Continued from page* 202)

Furnace Pressure Controls

A unique system of controlling the furnace stack damper was devised. It combines a pneumatic pressure controller with an electric damper motor that happened to be on hand.

The furnace pressure controller measures differential pressure in the range from -0.05 to $+0.15$ inch of water. Output of the furnace pressure controller's pneumatic proportional-plus-reset control unit is converted to electrical signals by four non-indicating pressure controllers. They are connected to the damper motor contactor coils through a repeat cycle cam timer. When the controller air output increases above a set point, one unit operates the damper motor intermittently through the cam timer or interrupter. If the air output keeps on increasing, a second unit operates the damper motor without interruption. If the air output decreases, the other two units operate the damper motor in the opposite direction.

The switches and gages in the center of the panel are for manual reversal of fuel and air flow from the north side burners to the south and vice versa every twenty minutes. Closing the fuel valve operates two limit switches that energize solenoid valves. One bleeds off air from the valve on the fuel line, shutting off the oil supply. The other bleeds air from the air-operated piston type unit opening the combustion air dampers wide to purge the furnace. A relay keeps the furnace pressure damper motor from being energized during furnace reversal.

The strip chart electronic potentiometer—in the upper right-hand corner of the panel—records temperatures at four points in the glass tank. Platinum thermocouples are located in the center line of the tank crown, between combustion air ports, and in the nose or refining end of the tank. The draft gages on the panel below the strip chart recorder are for furnace pressure, cooling air, stack draft and combustion air.

Advantages of Instrumentation

Instruments have improved operation in many important ways. Through the controlled rate of fuel flow, unscheduled temperature changes that could result in excessive deterioration of the furnace refractory walls are avoided.

Control of fuel-air ratio has improved combustion efficiency and reduced fuel consumption, and the fuel burned per ton of glass produced is one of the basic factors in plant economy. Control also helps maintain an oxidizing atmosphere that is desired in the furnace to reduce fluxing of the walls to a minimum, and to aid in producing a uniform glass color.

Keeping furnace pressure high enough has reduced air infiltration to a minimum, but the pressure is also kept low enough to prevent rapid destruction of the refractories. The right furnace pressure also affects length of flame and flame distribution throughout the glass tank. Furthermore, it prevents the flames from striking refractories. The result of automatic furnace pressure regulation has been increased refractory life and greater fuel economy.

Control of glass level in the tank has improved the quality of the final product, and reduced batch carry-over that deteriorates checker chambers. The furnace panel is the brain center of a system of sensory and motor nerves that make the whole operation function efficiently and smoothly.

PENNSALT PRESIDENT TO RETIRE

George B. Beitzel, President of the Pennsylvania Salt Manufacturing Company, has expressed to the Board of Directors his desire to retire later this year when he completes twenty-five years' service with the company. At the same time, he recommended that William P. Drake be appointed Executive Vice President and elected to Board membership. Both recommendations were approved.

"Mr. Drake's appointment as Executive Vice President," Mr. Beitzel said, "makes possible a gradual and orderly transfer of responsibility in the interim, and will enable us to carry forward our projected expansion program according to schedule."

While only 42 years of age, Mr. Drake has been a member of the Pennsalt organization for 21 years. He has served in technical and sales capacities at the company's various plants, and became President of the Industrial Chemicals Division in 1954.

1954 A.S.T.M. STANDARDS SUPPLEMENTS

Announcement has been made of the 1954 Supplements to the 1952 Book of A.S.T.M. Standards, issued triennially. Together with the 1952 Book and the 1953 Supplements published a year ago, they give in their latest form all of the A.S.T.M. specifications, tests, definitions, etc., except the chemical analysis of metals.

ANCHOR HOCKING ELECTS DIRECTORS AND OFFICERS

Wm. V. Fisher, President of Anchor Hocking Glass Corporation, has announced that Thomas S. Wright and Cyrus L. Fulton were elected Directors of the corporation at a special meeting of the Board of Directors. These directorships fill the vacancies created by the recent deaths of Thomas C. Fulton and B. E. Factor.

At the meeting, Mr. Fulton, who was formerly Treasurer, was elected to the office of Vice President in charge of Finance. M. C. Robson, General Offices Manager, was named Treasurer. James M. Hade, formerly Auditor, was named to the post of Comptroller. Donald K. McAllen, Director of Internal Control, was named Secretary of the firm.

In further re-alignment, Mr. Wright was named Vice President in charge of the Tableware Division and W. W. Smeck as Sales Manager.

• The 9th National Chemical Exposition will be held in Cleveland, Ohio, November 27-30, 1956. The 1956 show will be held under the joint auspices of the Chicago and Cleveland Sections of the American Chemical Society. Dr. G. C. Whitaker, Harshaw Chemical Company, is Chairman of the Exposition Committee of the Cleveland Section, and Arthur E. Schneider, Armour Laboratories, heads up the Chicago Section's Committee.

Inventions and Inventors . . .

(*Continued from page* 210)

faces by fusing together two sheets of the proper glasses and then dropping the laminated glass article by heating it while supported on a refractory support having surface curvatures so controlled as to produce an interface 6a, 7a of the desired contour. The nature of the refractory material itself is important. The preferred refractory must not stick to the glass during the heating and cooling operation. Moreover, it should be a composition having little or no tendency to change in shape or become distorted as to supporting surface shape during the actual dropping process. A composition for producing a material having the above desirable characteristics is given as follows:

Kyanite	grams	2400
Ball clay	grams	800
Chrome oxide	grams	800
Sodium carbonate	grams	4
Sodium silicate	grams	8
Triethanolamine	cc	2
Water		1000

The two outer faces of the members are ground and polished to a spherical curve or plano. Other applications of dropping of glass on a refractory surface to produce controlled surface curvatures are shown.

The patent contains 3 claims and 14 references.

Lens Grinding Apparatus. Fig. 8. Patent No. 2,686,391. Filed June 11, 1951. Issued August 17, 1954. Two sheets of drawings. Assigned to The Mitchell-Tyler Company by Harold M. Porter and Patrick H. Reardon.

This invention relates to methods and apparatus for the manufacture of lenses and more particularly to the commercial scale manufacture of lenses for microscopes and like instruments. Heretofore, enormous difficulty has been encountered in distributing the wear of the grinding compounds over the surface of the lens holder in such a way that the various lens blanks are ground to an equal extent and the curvature of the lens holder is maintained against distortion.

In operation the groove in the grinding disc 11, shown in Fig. 8, is filled with 26 blockers and is moistened with a water-lubricated silicon carbide or aluminum oxide grinding compound of about 35 microns. During the grinding operation, the spherical contours of the blockers are perfectly maintained due to the eccentricity of the grinding disc 11 and the plate 17 and its pad 18. This eccentricity causes the blocker balls to rotate about continuously changing axes, the balls describing a definite path. It is true that the balls in travelling around the groove in the grinding disc not only move around the groove, but twice in each revolution move from side to side across the groove. The relative speed difference between the grinding disc and the plate does not appear to affect the distribution of the wear over the blocker balls but rather tends to equalize the wear on the grinding disc.

The patent contains 7 claims and the following references were cited: 609,218, White, Aug. 16, 1898; 1,516,749, Moore et al., Nov. 25, 1924; 1,588,435, Adams, June 15, 1926; 1,706,723, Adams, Mar. 26, 1929; 1,811,219, Vetter, June 23, 1931; 1,870,328, Indge, Aug. 9, 1932; 2,075,216, Mancuso, Mar. 30, 1937; and 2,585,287, Turner et al., Feb. 12, 1952.

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Glass Division Papers . . .

(*Continued from page* 192)

will continue as Treasurer. Charles S. Pearce of Columbus, Ohio, is General Secretary. Chairman of the Glass Division is Frederic L. Bishop, Toledo, Ohio. The new Glass Division Chairman for the coming year is expected to be A. C. Siefert, Owens-Corning Fiberglas Corporation.

Research Digest . . .

(*Continued from page* 212)

to be more pronounced on the outside of the containers and appear to be typical of the various container glasses studied, making evaluation of the durability of the surface a difficult task.

The container glasses studied could be grouped into several classes: those in which the RO content was predominantly CaO, those in which the RO content is divided between CaO and MgO, those in which the ratio of CaO:MgO approaches that of dolomite ($CaCO_3 \cdot MgCO_3$) and those in which the Al_2O_3 content is exceptionally high.

The haze-meter curves rather closely resemble each other in each class. The high-Al_2O_3 glasses are characterized by low, flat per cent haze vs. time curves, which indicates that they are quite slow to break down or disintegrate. It should be pointed out, however, that these glasses are rather radically different in composition from the other glasses studied. The glasses containing magnesia show variable haze-meter curves and those which approximate the dolomite ratio (CaO:MgO) more closely approach the flat curves of the high-alumina glasses.

In general, the inside of the container appeared to corrode somewhat faster than that outside. This, however, was not always true. In some cases the deterioration of the inside and the outside was quite similar. It should be pointed out that all tests were run on samples cut from the wall of the container, thoroughly cleaned by scrubbing with a slurry of calcium carbonate and distilled water, rinsed in distilled water and dried by a blast of filtered air. Furthermore, before the replicas were made, each corroded sample was washed in distilled water and dried by a filtered air blast. The remaining residue, therefore, represented a permanent water insoluble film. It is realized that whenever narrow mouthed bottles are stored in an unheated warehouse, the weathering is much more severe on the inside surface than on the outside. This, no doubt, is due largely to the shape or to the neck construction of the bottle. For example, when the tops of narrow mouthed bottles are cracked off with a hot wire and the cylindrical part and bottom are subsequently stored with unmutilated bottles from the same lot, there is much less weathering on the inside surface of the mutilated bottles. This weathering approximates more closely in degree the lesser amount of action found on the outside surface.

• Lynch Corporation has again received a Certificate of Management presented by the American Institute of Management each year to those companies who have been outstanding in their management.

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IOWA UNIVERSITY ANNOUNCES MANAGEMENT COURSE

The College of Engineering, State University of Iowa, has announced the Sixteenth Management Course to be held June 13 through 25, 1955 in Iowa City.

To the intensive course of instruction is added a series of talks by recognized authorities on new developments, applications and problems in management techniques. The entire program is designed for those who have need to use these techniques—factory managers, foremen, industrial engineers, methods and time-study analysts, cost men, office executives and others in related work.

The areas of Production Planning, Job Evaluation, Motion and Time Study, Wage Incentives, Plant Layout, Materials Handling, Quality Control, Supervisory Training, Labor Relations and Legislation, Organization and Policy, and Public Speaking are included.

CARL C. KOHL, BRYCE PRESIDENT, DIES AT 38

Carl C. Kohl, Jr., 38-year old President of Bryce Brothers Company and head of the Pittsburgh Chapter of the Young Presidents Organization, died suddenly of cerebral hemorrhage.

Mr. Kohl, who was stricken en route to his office from his home, had been President of Bryce since 1951. He was formerly associated with Duncan-Miller Glass Company and Price Waterhouse & Company, certified public accountants.

A graduate of Lehigh University in 1938 with a Bachelor of Science degree, Mr. Kohl served with the U. S. Army's Rainbow Division in World War II.

Mr. Kohl is survived by his wife, the former Sally Cook; two children, Carl C. Kohl, III, and Kathy; his parents, Mr. and Mrs. Carl C. Kohl, Sr.

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At the recent meeting of the American Chemical Society, held in Cincinnati, Ohio, three papers were presented which were of interest to glassmen.

One paper presented was "Atomistic Approach to the Adhesion to Glass," which was presented by R. M. Gruver, Linden Laboratories, Inc., State College, Pa. The others were "The Adhesion of Polymeric Substances to Glass" by Frank Moser of Pittsburgh Plate Glass Company, and "Effect of Glass Fibers on the Cure of Silicone Resins" by H. A. Clark, Research Laboratories, and K. R. Hoffman, Production Engineering Laboratories, Dow Chemical Corporation.

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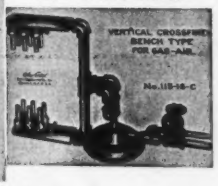

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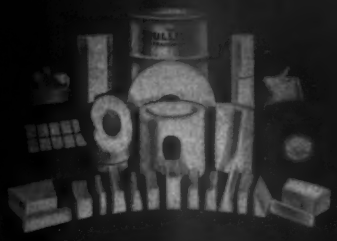

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